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**TECHNICAL DESCRIPTION AND USER'S GUIDE  
FOR THE ENHANCED TOTAL OBJECTIVE PLAN  
FOR OFFICER PROCUREMENT (TOPOPS)**

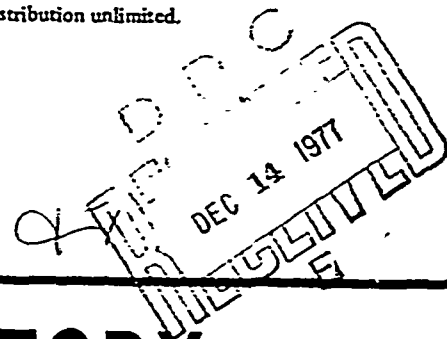
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) <p>This Technical Report documents an enhancement of the previously developed Total Objective Plan for Officer Procurement (TOPOPS) model. The TOPOPS model simulates, via the FMPS UNIVAC 1108 linear programming package, the optimal numbers and types of Air Force officers to procure within a 5-year horizon. It is designed to simulate officer accession and training and achieve optimal solutions in terms of either cost minimization or quality maximization. This enhanced technical description discusses the expansion of the supply pool and training agency parameters, the increase in the allowable number of valid constraints, and the procedures whereby the model may be utilized. It enhances documentation on the previous TOPOPS model by expanding user flexibility in defining and managing model parameters. Sample input forms, a sample problem, and associated computer output are included in Appendix A.</p>																	

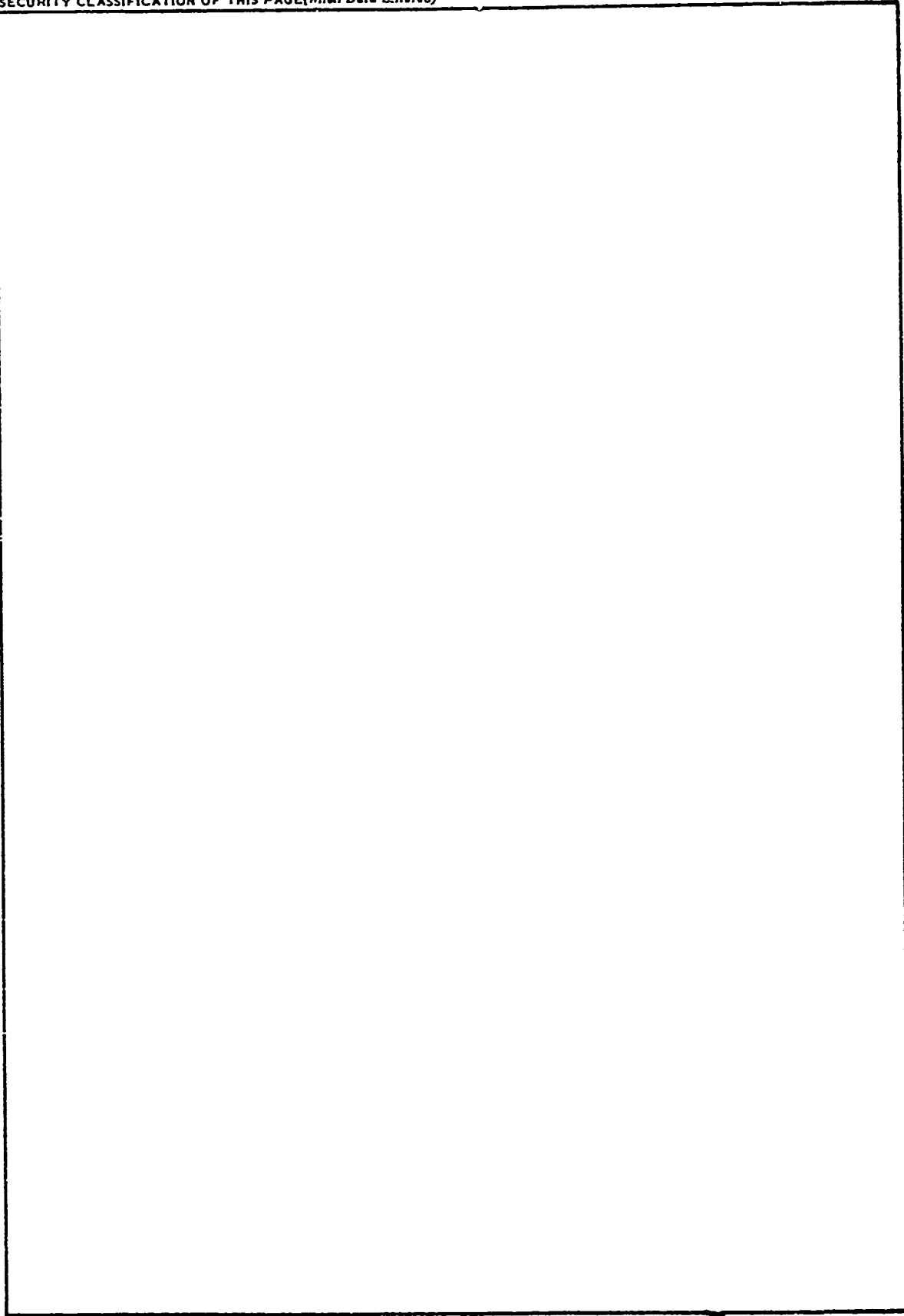
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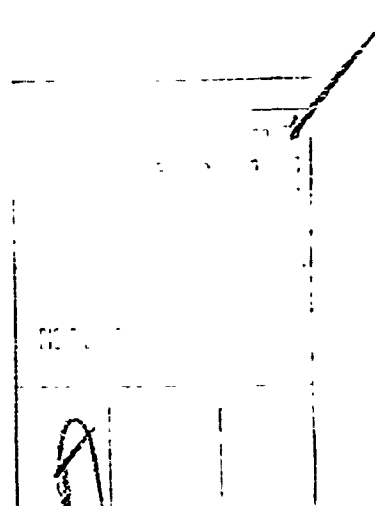
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## PREFACE

This report combines a technical description with a user's guide for the Enhanced Total Objective Plan for the Officer Procurement System (Enhanced TOPOPS). The Enhanced TOPOPS model is an expanded version of the TOPOPS model constructed under contract F41609-72-C-0042 by System Automation Corporation. The baseline model was documented in AFHRL-TR-73-73 and AFHRL-TR-73-76. This report documents the enhancements made to the original TOPOPS model and provides the user with specifics to aid in employment of the model. The modifications to the original TOPOPS model were suggested by 1st Lt James F. Roach and carried through by Capt Jon M. Knight and AIC Paul R. Stefanczyk, assisted by Mr. Larry T. Looper.



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## TECHNICAL DESCRIPTION AND USER'S GUIDE FOR THE ENHANCED TOTAL OBJECTIVE PLAN FOR OFFICER PROCUREMENT (TOPOPS)

### I. INTRODUCTION

#### A. Overview

This report consists of three sections including this introductory section.

Section II presents a complete mathematical description of the Total Objective Plan for the Officer Procurement System (TOPOPS) model. This description coincides with the conceptual model of the procurement system and is compatible with the TOPOPS computer programs.

Section III discusses the user input requirements and program outputs.

#### B. Conceptual View

Enhanced TOPOPS is a computer program that allows personnel managers and analysts to use operations research tools without extensive operations research training. It was designed by Air Force Human Resources Laboratory (AFHRL) in response to an expressed need by Air Force planners to be able to assess officer procurement system policy in terms of the possible trade-offs between the quality of entering Air Force officers and the costs of officer procurement programs.

The TOPOPS computer program takes as inputs the trained officer procurement requirements by officer type and requirement year, and information about the operating characteristics of the officer procurement system. It converts the inputs into a mathematical model that is structured in terms of:

1. Supply pools of potential officer candidates in the labor market (up to 20).
2. Sources of obtaining a commission (up to 20).
3. Training agencies for each officer type (up to 20).

The mathematical model then develops a 5-year procurement program that specifies:

1. The required number of officer candidates to be recruited from each supply pool.
2. The number of candidates to be entered into each commissioning source to generate the required number of officers (by type) from each source.
3. The number of officers from each commissioning source to be input to training schools or active duty to satisfy each year's trained personnel requirements.

The procurement program, selected by the model, either minimizes program costs while maintaining a desired officer quality distribution or maximizes officer quality while within a program budget. The model accounts for attrition and crossflows in commissioning sources, and it allows for attrition and crossflows among training agencies as a function of commissioning source. Also, of course, the model allows for the current state of the procurement pipeline (which was determined by past decisions) in determining future procurement actions.

Enhanced TOPOPS constructs a linear programming model compatible with the UNIVAC FMPS package on the UNIVAC 1108.

The basic costing concept used in TOPOPS is *program cost*. This cost is incurred directly and indirectly from the time an officer candidate enters a commissioning source to the time he completes his initial flying or technical training. "Cost per graduate" factors for the production and training stages are used to estimate program costs. These per-unit cost factors include both the direct and indirect costs, as well as account for attrition rate.

Several extensions of the basic cost concept have to be made in order to achieve an appropriate program cost function to TOPOPS.

First, production cost by its very nature is not a comprehensive measure of the costs of a particular set of procurement decisions. Because these decisions have long-run implications which do not show up until years later, focusing strictly on production costs as an objective function in an optimization model can result in a suboptimization. While it is beyond the scope of this effort to delve extensively into the long-term effects of procurement decisions, the cost function can, however, be modified to reflect the costs of replacement at some point in the future. Therefore, if a commissioning source produces officers whose average career length is short, its cost function in the short run can be penalized to reflect this eventuality. This model uses 20-year turnover rates for this purpose. Turnover rates are defined as the number of times an officer from the various commissioning sources must be replaced in a 20-year time frame.

Second, as already noted in the description of officer flow, procurement for any one year involves decisions made and training programs conducted over the preceding four or five years. The production costs minimized by TOPOPS are the program costs incurred to meet procurement requirements. The cost function is not time-phased, however, to represent annual budget costs but is aggregated to equal total program costs.

The seven (Other delineations of the commissioning sources may be specified by the user.) major commissioning sources for which TOPOPS has been tested include the following:

- AFROTC - 2-Year Program
- AFROTC - 4-Year Program
- SMSO - Non-Prior Service (NPS)
- SMSO - Airman Commissioning Program (ACP)
- SMSO - Airman Education and Commissioning Program (AECF)
- SMSO - Bootstrap Commissioning Program (BCP)
- United States Air Force Academy - (USAFA)

Because of the generalized nature of the model the analyst is in no way restricted to these specific commissioning sources.

The TOPOPS quality concept focuses on entry-level quality and is operationalized using various devices and assumptions. These include the following:

1. Due to limited data, TOPOPS now addresses the measurement of officer candidate quality at the time of entry into the various commissioning sources.
2. The present method for measuring quality in the TOPOPS context is through the use of Air Force Officer Qualifying Test (AFOQT) scores. Based on past research, it is generally accepted that officer candidates with higher AFOQT scores will have a greater probability of success than candidates with lower scores.
3. We assume supply pools can be characterized by a distribution of AFOQT scores.
4. The AFOQT is no more than a partial measure of quality and hence, treatment of the quality concept should be extended beyond the use of AFOQT scores.
5. Two measures of extending the quality concept used in TOPOPS are the inclusion of *selective recruitment* and *selective procurement*. Selective recruitment assumes that the Air Force will be required to obtain officer candidates from different supply pools (e.g., quotas from various sub-groups of the U.S. population) and that some people with somewhat lower AFOQT scores than would be selected if quotas were not imposed can and will make successful Air Force (AF) officers. Selective procurement is used to insure that all commissioning sources provide at least some minimum proportion of the requirements.
6. An additional means for extending the quality concept is to define the supply pools in terms of parameters other than AFOQT scores. These may include physical, mental, moral, and educational standards.

These then, are the means for addressing the quality concept in TOPOPS. Although this is not a wholly satisfactory approach, it enables us to model some of the principal procedures used by personnel planners to achieve a quality force.

Until an improved operational concept of quality is developed, the approach mapped out here appears as satisfactory as is possible. We do not regard this approach as "optimizing quality" but as a set of techniques which, if used judiciously, raise the probability of achieving a quality officer force.

The general structure of the model appears in Table 1. As shown, there are two objective functions and five sets of constraints. The analyst chooses among these to formulate his problem.

Table 1. General Structure of TOPOPS Model

Model Component	Description	Reference
Objective	MINIMIZE: Total Production Costs	II.1
	MAXIMIZE: Overall quality of officers produced	II.2
Constraint	SUBJECT TO:	
	Quality Distribution	II.3
	Annual Budgets	II.4
	Supply of officer candidates:	
	1. to each commissioning source	II.5
	2. from each supply pool	II.6
	Training requirements	II.7
	Policy and Operating characteristics	
	1. Agency restrictions	II.8 -9
	2. Selective production	II.10-11
	3. Selective recruitment	II.12-13

The model provides a choice between two objective functions. The first minimizes total program cost. The other maximizes entry-level quality of officers as measured by average AFOQT scores.

Five set of constraints are considered. The first set is designed to represent a series of program budget constraints which assure that expenditures for procurement do not exceed specified levels. The second set consists of quality distribution constraints. These constraints are designed to force procurement of officer candidates exhibiting a range of average AFOQT scores.

The other sets of constraints deal with supply, procurement requirements, and policy and operating characteristics of the procurement system. The third set of constraints, supply, reflects limitations on the production of officers resulting from the size of supply pools and the ability of different commissioning sources to recruit men from particular pools. A fourth set, the requirements constraints, specifies minimum production levels which must be achieved in order to provide sufficient commissioned officers to meet the procurement requirements established by the Air Force. Finally, the policy and operating constraints reflect limitations in the production capacities of the various commissioning sources as well as explicit policies to assure that certain supply pools and certain commissioning sources provide either minimum or maximum numbers of officers.

TOPOPS solution variables specify optimal procurement schedules. The schedule indicates a mix of commissioned officers of different types produced by the various commissioning sources. The model either minimizes cost or maximizes quality while satisfying the various constraints.

### C. Summary: The TOPOPS Design

The TOPOPS computer model may be operated in one of two modes by formulating the objective function to either minimize program costs or maximize entry-level quality. A brief discussion of these objective functions and five sets of possible constraints follows. A detailed non-technical discussion for the original version may be found in AFHRL-TR-73-73.

## II. TOPOPS: THE MATHEMATICAL MODEL

### A. Introduction

This section is written to satisfy the needs of two audiences. One is the users who require a detailed explanation of the mathematical logic of TOPOPS. Second are the program analysts responsible for the maintenance and operation of the analytical and computer model.

The central module of TOPOPS is the Procurement Policy Generator which is basically a linear programming algorithm. This section provides its complete specifications. The model determines the optimal procurement schedule of officers by commissioning source in order to meet requirements for twenty different types of officers over any 5-year period.

Paralleling the structure of the linear program, the formulation of the model here focuses on the key structural elements. These include the solution variables, the objective function, and the constraints.

### B. Solution Variables

The TOPOPS Procurement Policy Generator is a generalized linear programming model which determines production and recruitment levels for each commissioning source and officer type. The model is generalized in the sense that it includes the capability of filling requirements for up to twenty officer types from as many as twenty commissioning sources.

The optimal procurement mix is specified by two types of solution variables pertaining to recruitment flows and commissioning source production symbolically defined as:

$F_{kijt}$  = the number of candidates taken from supply pool  $k$  for type  $i$  officers by commissioning source  $j$  to meet year  $t$  procurement requirements.

$x_{ijt}$  = the number of commissioned officers of type  $i$  produced by commissioning source  $j$  for year  $t$  procurement requirements.

When an optimal solution is determined, the values of these variables represent a recruitment and production policy which optimizes an objective function, either minimizing program cost or maximizing a measure of officer entry-level quality, while satisfying various qualitative and quantitative constraints.

The model is time-phased over five years. The first year of the 5-year model period, termed the base year, is denoted  $t_B$  with subsequent years labeled  $t_B+1, t_B+2, \dots, t_B+4$ . Because the total time required for preparation in a commissioning source plus specialized training (such as UPT/UNT) can be as much as five years, the model considers decisions which can occur in any of the ten years between  $t_B-5$  and  $t_B+4$ .

These time lags in the officer procurement system affect the TOPOPS model in two ways. First, the subscript  $t$  must be carefully defined to refer to the year in which the procurement requirement exists. When  $t$  is associated with the variables  $x_{ij}$  and  $r_{ij}$ , it refers not to the years in which the training requirements, officer production, and recruiting requirements respectively occur, but rather to the year in which the officers generated by these activities will be available to satisfy procurement requirements.

Second, the subscript  $y$  is used to indicate the year in which recruitment, training and other activities occur in order to meet the procurement requirement in year  $t$ .

We caution the reader to understand these two time subscripts,  $t$  and  $y$  in order to more easily interpret the mathematical formulation.

As written, the function is non-linear since R is a function of the solution variables. However, the maximum average AFOQT score occurs when the total AFOQT score is maximized. Therefore, we define the quality function in a simpler form as follows:

$$\text{II.2 Maximize } \sum_{k=1}^{20} \sum_{i=1}^{20} \sum_{j=1}^{20} \sum_{t=t_B+4}^{t_B+4} A_k F_{kijt}$$

An objective function of this type can be improperly used if constraints are not carefully defined. The reason is that the total AFOQT score can be increased simply by recruiting more men. Every additional candidate selected from a supply pool increases the total. To prevent this, training requirements which might otherwise be defined as minimum levels which could be exceeded are formulated in a subsequent section as equalities.

#### D. Production Stage Inputs and Outputs

Inputs to the production system are candidates while the outputs are commissioned officers. A certain number of candidates who enter a commissioning source never become commissioned officers. Others graduate but are not qualified for the type of training for which they were recruited. This attrition and crossflow that occur in the production stage can be viewed in the form of crossflow matrices, one defined for each commissioning source. Each matrix contains entries which indicate the proportion of candidates (entering that source qualified to become the type of officer indicated by the column in which the entry appears) who graduate qualified for training of the type indicated by the row. We formally define the production crossflow matrix for each source j as follows:

$$p^j = p^{i'i} = \begin{bmatrix} P_{1,1} & P_{1,2} & \dots & P_{1,20} \\ P_{2,1} & & & \\ \vdots & & & \\ P_{20,1} & \dots & \dots & P_{20,20} \end{bmatrix}$$

where  $p^{i'i}$  = proportion of candidates who enter source j qualified for type i and leave as type i'.

$$0 \leq p^{i'i} \leq 1$$

$$\sum_{i'=1}^{20} p^{i'i} \leq 1 \quad \text{For } i = 1, \dots, 20$$

These matrices allow us to express the number of graduates from each commissioning source represented by the model solution variables  $x_{ijt}$  as a function of the number of candidates as follows:

$$p^j \begin{pmatrix} r_{1jt} \\ \vdots \\ r_{20jt} \end{pmatrix} = \begin{pmatrix} x_{1jt} \\ \vdots \\ x_{20jt} \end{pmatrix}$$

As written, the function is non-linear since  $R$  is a function of the solution variables. However, the maximum average AFOQT score occurs when the total AFOQT score is maximized. Therefore, we define the quality function in a simpler form as follows:

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$$p_j = p_{i'i} = \begin{bmatrix} P_{1,1} & P_{1,2} & \dots & P_{1,20} \\ P_{2,1} & & & \\ \vdots & & & \\ P_{20,1} & \dots & \dots & P_{20,20} \end{bmatrix}$$

where  $p_{i'i}$  = proportion of candidates who enter source  $j$  qualified for type  $i$  and leave as type  $i'$ .

$$0 \leq p_{i'i} \leq 1$$

$$\sum_{i'=1}^{20} p_{i'i} \leq 1 \quad \text{For } i = 1, \dots, 20$$

These matrices allow us to express the number of graduates from each commissioning source represented by the model solution variables  $x_{ijt}$  as a function of the number of candidates as follows:

$$p_j \begin{pmatrix} r_{1jt} \\ \vdots \\ r_{20jt} \end{pmatrix} = \begin{pmatrix} x_{1jt} \\ \vdots \\ x_{20jt} \end{pmatrix}$$

where:  $p^j$  = production crossflow matrix for source  $j$   
 $r_{ijt}$  = the number of candidates of type  $i$  entering source  $j$  for year  $t$   
 $x_{ijt}$  = the number of officers of type  $i$  produced by source  $j$  for year  $t$

This system can be solved for the number of candidates as a function of the solution variables. We, therefore, have the identity relationship:

$$\begin{pmatrix} r_{1jt} \\ \vdots \\ r_{20jt} \end{pmatrix} = p^{j-1} \begin{pmatrix} x_{1jt} \\ \vdots \\ x_{20jt} \end{pmatrix}$$

The proportion of candidates who drop out of a commissioning source before graduation (the attrition rate) can be calculated explicitly as follows:

$$\text{Dropout \% for candidate of type } i = 1 - \sum_{i'=1}^{20} p_{i'i} \quad \text{For } i = 1, \dots, 20$$

The crossflow matrices provide the capability for the conversion of a quantity of entering candidates to an equivalent number of graduates and vice versa. Consequently, keeping in mind the identity relationship, we can formulate the model relationships using either the solution variables  $x_{ijt}$  or the number of candidates  $r_{ijt}$ , whichever is more convenient. This fact allows us to more clearly and easily specify the constraints.

Figure 1 shows the crossflow matrices for an illustrative production system with only two commissioning sources, each producing two types of officers. Converting the matrix entries for source 1 to fractions for ease of calculation, we solve for the  $x_{ij}$ 's (omit  $t$  for simplicity):

$$p^1 \begin{bmatrix} r_{ij} \end{bmatrix} = \begin{bmatrix} x_{ij} \end{bmatrix}$$

$$p^1 \begin{pmatrix} r_{11} \\ r_{21} \end{pmatrix} = \begin{pmatrix} x_{11} \\ x_{21} \end{pmatrix}$$

$$\begin{bmatrix} 3/5 & 0 \\ 1/5 & 1/2 \end{bmatrix} \begin{pmatrix} r_{11} \\ r_{21} \end{pmatrix} = \begin{pmatrix} x_{11} \\ x_{21} \end{pmatrix}$$

$$\begin{aligned} 3/5 r_{11} &= x_{11} \\ 1/5 r_{11} + 1/2 r_{21} &= x_{21} \end{aligned}$$

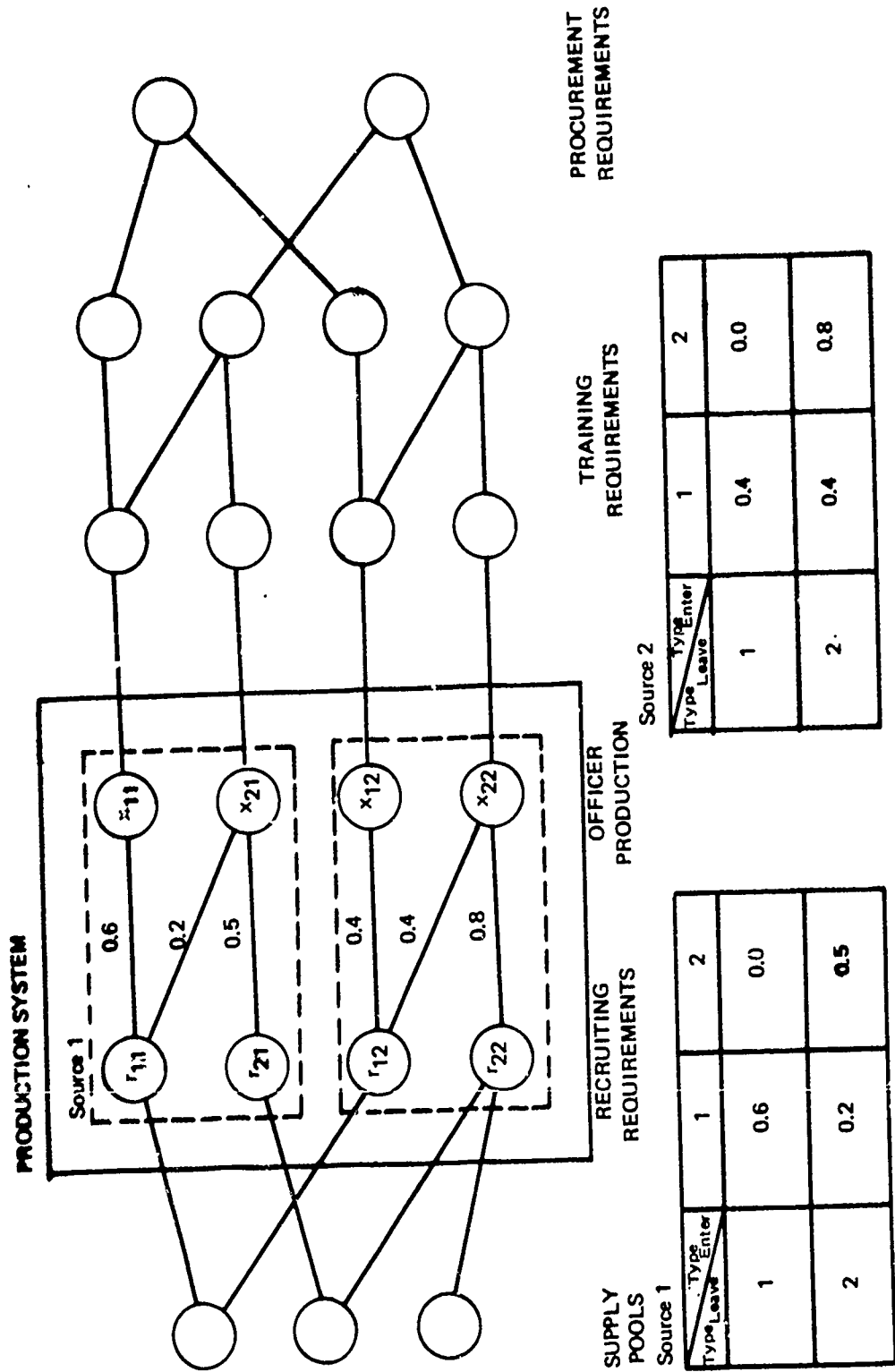


Figure 1. Relationship between commissioning source candidates and graduates.

The  $r_{ij}$ 's are determined as follows:

$$\begin{aligned} \begin{pmatrix} r_{ij} \end{pmatrix} &= \begin{bmatrix} p^1 \end{bmatrix}^{-1} \begin{pmatrix} x_{ij} \end{pmatrix} \\ \begin{pmatrix} r_{11} \\ r_{21} \end{pmatrix} &= \begin{bmatrix} p^1 \end{bmatrix}^{-1} \begin{pmatrix} x_{11} \\ x_{21} \end{pmatrix} \\ \begin{pmatrix} r_{11} \\ r_{21} \end{pmatrix} &= \begin{bmatrix} 5/3 & 0 \\ -2/3 & 2 \end{bmatrix} \begin{pmatrix} x_{11} \\ x_{21} \end{pmatrix} \\ r_{11} &= 5/3 x_{11} \\ r_{21} &= -2/3 x_{11} + 2 x_{21} \end{aligned}$$

#### E. Constraints

The values which the solution variables can assume are limited by the constraints in the TOPOPS model. There are five basic types of constraints relating to candidate quality, program budget limitations, the supply of officer candidates, training requirements, and the operating characteristics of commissioning sources.

Having selected an objective function which optimizes either program cost or officer candidate entry-level quality, the personnel analyst may choose to constrain the item which is not optimized. Although they can be used in formulating TOPOPS problems regardless of the objective function, the quality distribution and program budget constraints are used for this purpose.

1. *Quality Distribution Constraints.* The minimum proportions of the total recruitment requirement which should be filled with candidates from particular supply pools are specified using quality distribution constraints. They can be used to insure that individuals entering the force are selected from candidates with a wide range of AFOQT scores. Usually this set of constraints is used with the cost minimization objective function. The basic mathematical formulation for these constraints appears as follows:

$$(II.3) \quad \sum_{i=1}^{20} \sum_{j=1}^{20} F_{kijt} \geq \pi_{kt} \sum_{i=1}^{20} \sum_{j=1}^{20} r_{ijt} \quad \text{For } k = 1, \dots, 20 \\ t = t_B, \dots, t_B+4$$

where:  $\sum_{i=1}^{20} \sum_{j=1}^{20} F_{kijt}$  = total number of candidates taken from supply pool k for year t procurement requirements.  
 $\pi_{kt}$  = proportion of the total recruitment which should be filled with candidates from supply pool k for year t procurement requirements.  
 $\sum_{i=1}^{20} \sum_{j=1}^{20} r_{ijt}$  = total recruitment for year t procurement requirements.

2. *Program Budget Constraints.* The costs of procuring and training officers to meet requirements in a specific year may be constrained by a program budget limit. Important to understand is the nature of the TOPOPS costs. These are program costs rather than budgetary or accounting-type costs. The costs account for turnover and other system features which are considered important with respect to the allocation algorithm and policy analysis in terms of improving the officer force. For each year in the planning horizon there may be a program budget constraint. Usually, this set of constraints is used with the quality maximization function. The constraint is formulated in the following manner:

$$(II.4) \quad \sum_{i=1}^{20} \sum_{j=1}^{20} [c_j + \sum_{i'=1}^{20} c_{i'} d_{i'ij}] T_{ij} x_{ijt} \leq B_t \quad \text{For } t = t_B, \dots, t_B+4$$

where:  $c_j$  = production cost per source  $j$  graduate  
           = pay and allowances + other cost  
 $c_i'$  = training cost per officer type  $i'$   
 $d_{i'ij}$  = training program crossflows for entering officer type  $i$  who leaves as officer type  $i'$  from source  $j$   
 $T_{ij}$  = turnover of officers type  $i$  from source  $j$   
 $x_{ijt}$  = number of commissioned officers of type  $i$  produced by commissioning source  $j$  for year  $t$  procurement requirements  
 $B_t$  = program budget for year  $t$

3. *Supply Constraints.* Production of the commissioning sources is constrained by the manpower resources available. Figure 2 illustrates the basic nature of supply in the procurement system. Between any supply pools  $S_k$  and any recruiting requirement  $r_{ijt}$ , there is a potential relationship. Either the individuals in the pool are available to fill the recruiting requirement or  $S_k$  and  $r_{ijt}$  have no relationship. We define a coefficient to reflect these two states as follows:

$\sigma_{kyijt}$  = indicator of the availability of supply pool  $k$  in year  $y$  to provide candidates of type  $i$  to source  $j$  for year  $t$  procurement requirements

where:  $\sigma_{kyijt}$  = 1 if  $S_k$  is available to fill  $r_{ijt}$  in year  $y$

$\sigma_{kyijt}$  = 0 if there is no relationship between  $S_k$  and  $r_{ijt}$  in year  $y$

In order to formally specify the relationships between supply and production, consider the variable defined below:

$F_{kijt}$  = the number of candidates from supply pool  $k$  qualified for type  $i$  taken by source  $j$  for year  $t$ .

The values for  $F_{kijt}$  represent the flow of candidates across the arcs connecting the supply pools and commissioning sources. There are potentially 40,000 of these flow variables, too many to be efficiently handled by TOPOPS. It is not unreasonable, however, to limit the number of variables and hence the number of relationships between supply pools and recruiting requirements to 4,000. Many sources select candidates with particular officer-type qualifications from only a few or just one supply pool(s). Similarly, most supply sources provide candidates to a small number of commissioning sources. Consequently, although there are 40,000 potential relationships, limiting the number of arcs between supply pools and recruiting requirements to 4,000 should have no practical significance.

There are two supply constraints. The first is an identity which specifies that a recruiting requirement  $r_{ijt}$  is exactly equal to the total flow of candidates over all arcs connecting  $r_{ijt}$  to the various supply sources. The second requires that the total flow in year  $y$  of candidates from a particular supply pool  $S_k$  to all commissioning sources cannot exceed the number of potential candidates in that supply pool. Formally, the supply constraints are written:

$$(II.5) \quad \sum_{y=t_B-5}^{20} \sum_{k=1}^{20} \sigma_{kyijt} F_{kijt} = r_{ijt} \quad \text{For } \begin{matrix} i = 1, \dots, 20 \\ j = 1, \dots, 20 \\ t = t_B, \dots, t_B+4 \end{matrix}$$

$$(II.6) \quad \sum_{t=t_B}^{t_B+4} \sum_{i=1}^{20} \sum_{j=1}^{20} \sigma_{kyijt} F_{kijt} \leq S_{ky} \quad \text{For } \begin{matrix} k = 1, \dots, 20 \\ y = t_B-5, t_B-4, \dots, t_B+4 \end{matrix}$$

where:  $r_{ijt}$  = the number of candidates of type  $i$  entering source  $j$  for year  $t$

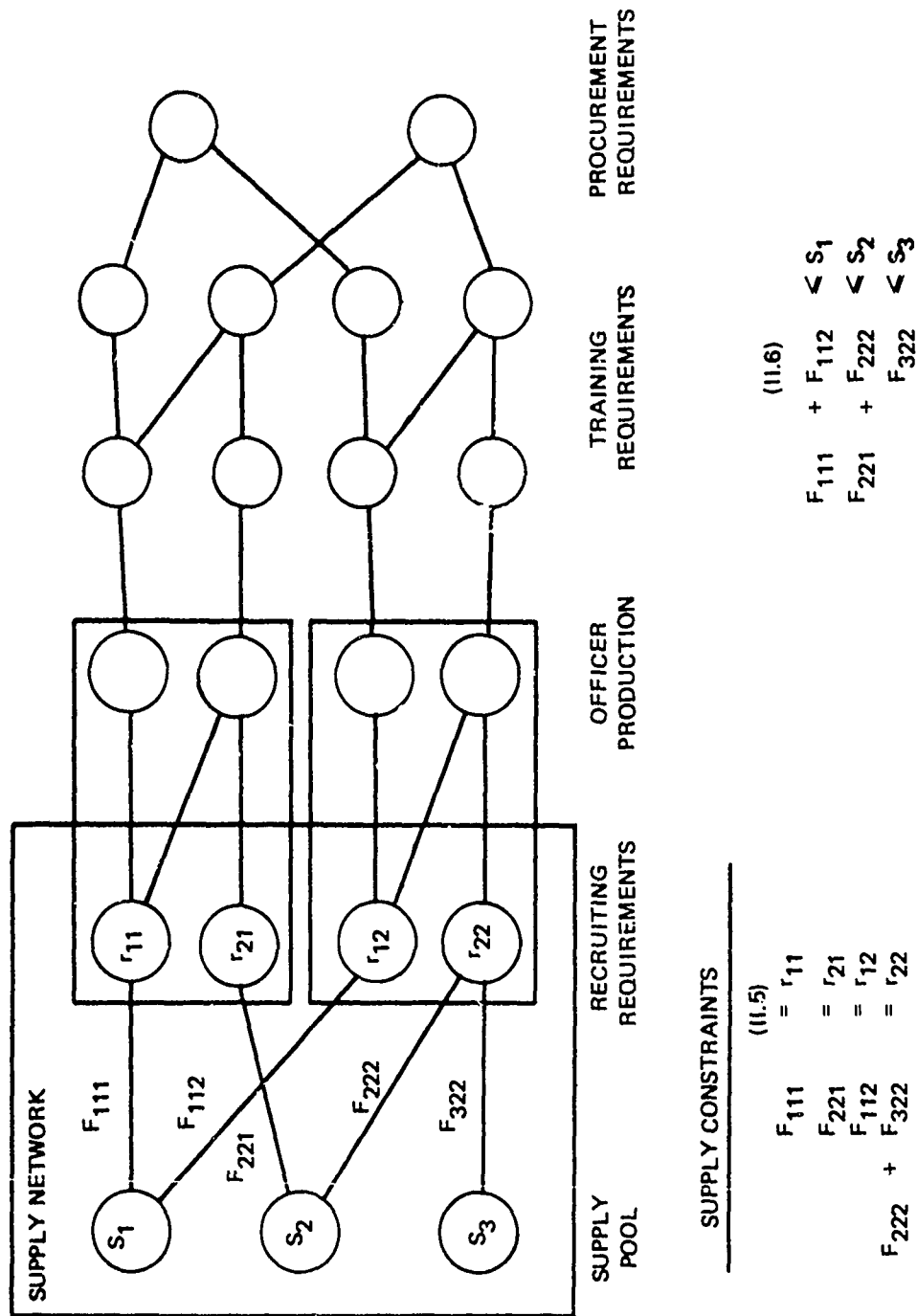


Figure 2. Supply relationships.

- $S_{ky}$  = supply from supply pool k available to meet recruitment requirements in year y  
 $\sigma_{kyijt}$  = indicator of availability of  $S_{ky}$  to  $r_{ijt}$   
 $F_{kijt}$  = flow of candidates from  $S_k$  or  $r_{ij}$  for year t procurement requirements

The model recognizes that the various supply pools are not constant from year-to-year. The number of potential candidates available from a supply source to a commissioning source for the production of officers of a particular type depends upon the year in which recruiting occurs. Consequently, the model must constrain production by the size of the supply pools available in the year in which recruitment requirements exist. The Data Initializer determines the relationship for particular procurement requirements and commissioning sources between the subscript y associated with the variables  $S_k$  and the subscript t as follows:

$$y = t - \ell_i - \ell_j$$

- where: y = year in which supply pool k is available to satisfy recruiting requirements  
 t = year in which the procurement requirements exists  
 $\ell_i$  = number of years required for training for type i  
 $\ell_j$  = number of years required for production at source j.

An example of supply constraints appears in Figure 2.

4. *Requirement Constraints.* Strength objectives and procurement requirements such as those generated by TOPLINE provide the basis for TOPOPS requirement constraints which specify yearly levels for officer procurement. The Data Initializer determines the total number of officers of each type who must enter in order to meet the procurement requirements. The number required for training differs from the procurement requirements due to the attrition and crossflow which occur within the training stage.

A useful feature of the enhanced TOPOPS is that attrition which occurs during the training stage has been made a function of the source of commissioning.

As previously noted, the TOPOPS solution variables must satisfy the training requirements as strict equalities to optimize quality. The general mathematical formulation for the requirement constraints is:

$$(II.7) \quad \sum_{i,j=1}^{20} d_{i^1ij} x_{ij}(t-T_{i^11}) = \theta_{i^11t} \quad \text{For } i^1 = 1, \dots, 20 \\ t = t_B, \dots, t_B+4$$

- where:  $d_{i^1ij}$  = Proportion of officers commissioned from source j who enter training as type i and emerge as type  $i^1$ .  
 $\theta_{i^11t}$  = Specified procurement requirements for the year t of type  $i^1$  officers.  
 $x_{ijt}$  = production of type i qualified officers emerging from commissioning source j in year t.  
 $T_{i^11}$  = the greatest integer function of the length of training for an officer of type  $i^1$ .

*Artificial Commissioning Source and Infeasibilities.* It is possible in a linear programming model for the constraints to preclude any feasible solution. This would be the case, for instance, if the supply and maximum production constraints did not permit production levels which satisfied the requirement and minimum production constraints. It is reasonable to assume, however, that excess requirements can always be satisfied by the recruitment of individuals who would otherwise be regarded as unavailable by the Air

Force. Additional candidates can be acquired by either lowering standards or increasing pay. So that the model will arrive at a solution when these constraints would otherwise be binding, we specify a special commissioning source which has its own unlimited supply pool and can produce officers of any type to satisfy requirements which otherwise would not be met because of model constraints.

The cost for this hypothetical commissioning source is set at an arbitrarily high level so that when minimizing costs, it is always advantageous to completely utilize other sources first. Similarly, by assuming an average AFOQT score of zero, a quality maximization problem would select officers from this source only if no others were available. Because the production of this agency is unconstrained by supply, its inclusion as a solution variable in the requirement constraints assures that TOPOPS will always generate an optimal solution. We formally define the following:

$$x_{iot} = \text{production of officers of type } i \text{ in year } t \text{ from supplemental sources of candidates}$$

Along with the inclusion of this variable in the constraints, the objective function is also modified to reflect this artificial cost. In this case, we include in the objective function the term

$$c_0 x_{iot}$$

where  $c_0$  = annual production cost of hypothetical source

$$c_0 > > c_j, j = 1, \dots, 20$$

also:  $A_0$  = average AFOQT score of supplementary source  
= 0

Infeasibilities may occur for reasons other than those addressed by the artificial source. For example, the quality distribution, selective production, and selective recruitment constraints could be specified in such a way that procurement requirements cannot be met. The complexity of the procurement system, due to crossflows and attrition, obscures the relationships between these constraints. Infeasibilities can be avoided and their causes determined if constraints are systematically introduced and their effects are analyzed before further constraints are imposed.

5. *Policy and Operating Characteristics Constraints.* In addition to assuring that the optimal solution satisfies training requirements within the limitations on supply, TOPOPS constraints limit the values which the solution variables can assume as a result of the operating characteristics of the various commissioning sources in the procurement system. There are three general categories of policy and operating characteristics pertaining to: (a) operations, (b) selective production, and (c) selective recruitment.

a. *Operating Constraints.* The total production of officers by a commissioning source is restricted by capacity and economic considerations. Operating constraints reflecting these restrictions specify the smallest and largest number of officer candidates of all types that can enter a commissioning source in a given year. These constraints when specifying a minimum number of candidates establish a lower limit on entering class size; if a maximum, the constraint represents a ceiling. These constraints when used with equalities on the righthand side, that is, the maximum and minimum levels are equal, indicate a fixed level of production for the particular source. Where appropriate, this may be interpreted and used to show current production. The constraints are formulated as follows:

$$(II.8) \quad \sum_{t=t_B}^{t_B+4} \sum_{i=1}^{20} W_{yijt} r_{ijt} \geq L_{jy} \quad \text{For } j=1,2,\dots,20 \quad y=t_B-5,\dots,t_B+4$$

$$(II.9) \quad \sum_{t=t_B}^{t_B+4} \sum_{i=1}^{20} W_{yijt} r_{ijt} \leq U_{jy} \quad \text{For } j=1,2,\dots,20 \quad y=t_B-5,\dots,t_B+4$$

where  $W_{yijt}$  = indicator that recruitment must occur in year  $y$  of officer type  $i$  for source  $j$  to meet procurement requirement in year  $t$   
 = 1, if recruitment occurs in year  $y$   
 = 0, if recruitment does not occur in year  $y$   
 $r_{ijt}$  = number of candidates of type  $i$  entering source  $j$  for year  $t$  procurement requirements  
 $L_{jy}$  = minimum number of candidates of all types entering source  $j$  in year  $y$   
 $U_{jy}$  = maximum number of candidates of all types entering source  $j$  for year  $y$

b. *Selective Production Constraints.* The second set of operating and policy constraints, selective production, allows the TOPOPS user to indicate minimum and maximum levels of production of a specific officer type by a particular commissioning source. Either a number of officers or a proportion of the training requirements for a specific officer type can be used to specify maximum and minimum production levels. Selective production constraints provide the capability for spreading procurement over a number of commissioning sources.

These constraints are formulated as follows:

$$(II.10) \quad x_{ijt} \geq M_{ijt} = \psi_{ijt} \sum_{j=1}^{20} X_{ijt} \quad \text{For } \begin{matrix} i=1, \dots, 20 \\ j=1, \dots, 20 \\ t=t_B, \dots, t_B+4 \end{matrix}$$

$$(II.11) \quad x_{ijt} \leq N_{ijt} = \beta_{ijt} \sum_{j=1}^{20} X_{ijt} \quad \text{For } \begin{matrix} i=1, \dots, 20 \\ j=1, \dots, 20 \\ t=t_B, \dots, t_B+4 \end{matrix}$$

where:  $x_{ijt}$  = number of officers of type  $i$  produced by a source  $j$  for year  $t$  procurement requirements  
 $M_{ijt}$  = minimum number of commissioned officers of type  $i$  from source  $j$  who should enter training to meet year  $t$  procurement requirements  
 $N_{ijt}$  = maximum number of commissioned officers of type  $i$  from source  $j$  who should enter training to meet year  $t$  procurement requirements  
 $\psi_{ijt}$  = minimum proportion of the commissioned officers of type  $i$  from source  $j$  entering training to meet year  $t$  procurement requirements  
 $\beta_{ijt}$  = maximum proportion of the commissioned officers of type  $i$  from source  $j$  entering training to meet year  $t$  procurement requirements

c. *Selective Recruitment Constraints.* Finally, the personnel analyst may want to restrict the number of candidates from a supply pool used by a given commissioning source for the production of a particular officer type. That is, the flows between the supply pools and commissioning sources may be limited. Selective recruitment constraints, which indicate the minimum or maximum number of candidates which can be recruited from a supply pool by a source for the production of officers of a particular type, provide the capability for spreading recruitment over a number of supply pools. The constraints are formed in the following manner:

$$(II.12) \quad F_{kijt} \geq \alpha_{kijt} r_{ijt} \quad \text{For } \begin{matrix} k=1, \dots, 20 \\ i=1, \dots, 20 \\ j=1, \dots, 20 \\ t=t_B, \dots, t_B+4 \end{matrix}$$

$$(II.13) \quad F_{kijt} \leq \delta_{kijt} r_{ijt} \quad \text{For } k=1, \dots, 20 \\ i=1, \dots, 20 \\ j=1, \dots, 20 \\ t=t_B, \dots, t_B+4$$

where:  $F_{kijt}$  = the number of candidates taken from supply pool k for type i by source j to meet year t requirements

$\alpha_{kijt}$  = minimum proportion of the candidates which should come from supply pool k of type i entering source j for year t procurement requirements

$\delta_{kijt}$  = maximum proportion of the candidates which should come from supply pool k of officer i entering source j for year t procurement requirements

$r_{ijt}$  = the number of candidates of type i entering source j for year t procurement requirements.

In summary, all three types of policy and operating constraints specify maximum and minimum levels for procurement system activities: operating constraints pertain to the total production of officers by a commissioning source, selective production constraints pertain to the production of officers of a particular type by a commissioning source and selective recruitment constraints pertain to the flow of candidates from supply pools to commissioning source. In each case the TOPOPS analyst can indicate a fixed level of activity by merely specifying the desired total production, officer production or recruitment quantity using both the maximum and minimum constraints with the same right-hand side.

#### F. Model Summary

Figure 3 represents a summary of the TOPOPS linear programming model including formulations for the objective function and constraining relationships and definitions of the model variables, coefficients, right-hand sides and subscripts. The exact magnitude of the model for any particular application is largely determined by the number of supply pools, officer types, commissioning sources, and operating limitations specified. We can estimate, however, the largest number of constraints and variables which can be included in the model. For most model runs, these estimates will greatly exceed the magnitude of the problem.

#### MODEL FORMULATION

Optimize the objective function:

$$(II.1) \text{ Minimize } \sum_{t=t_B}^{t_B+4} \sum_{i=1}^{20} \sum_{j=1}^{20} [c_j + \sum_{i'=1}^{20} c_{i'} d_{i'ij}] (1+I) T_{ij} x_{ijt}$$

$$(II.2) \text{ Maximize } \sum_{t=t_B}^{t_B+4} \sum_{i=1}^{20} \sum_{j=1}^{20} \sum_{k=1}^{20} A_k F_{kijt}$$

Subject to constraints pertaining to:

##### Quality Distribution

$$(II.3) \quad \sum_{i=1}^{20} \sum_{j=1}^{20} F_{kijt} \geq \pi_{kt} \sum_{i=1}^{20} \sum_{j=1}^{20} r_{ijt} \quad \text{For } k=1, \dots, 20 \\ t=t_B, \dots, t_B+4$$

Figure 3. TOPOPS model summary.

### Annual Budgets

$$(II.4) \sum_{i=1}^{20} \sum_{j=1}^{20} [c_j + \sum_{i'=1}^{20} c_{i'} d_{i'ij}] T_{ij} x_{ijt} \leq B_t$$

For  $t=t_B, \dots, t_B+4$

### Supply

$$(II.5) \sum_{y=t_B-5}^{20} \sum_{k=1}^{20} \sigma_{kyijt} F_{kijt} = r_{ijt}$$

For  $i=1, \dots, 20$   
 $j=1, \dots, 20$   
 $t=t_B, \dots, t_B+4$

$$(II.6) \sum_{t=t_B}^{t_B+4} \sum_{i=1}^{20} \sum_{j=1}^{20} \sigma_{kyijt} F_{kijt} \leq S_{ky}$$

For  $k=1, \dots, 20$   
 $y=t_B-5, \dots, t_B+4$

### Requirements

$$(II.7) \sum_{i=1}^{20} \sum_{j=1}^{20} d_{i1ij} x_{ijt} (t - T_{i1}) = \theta_{i1t}$$

For  $i'=1, \dots, 20$   
 $j=1, \dots, 20$   
 $t=t_B, \dots, t_B+4$

### Policy and Operating Characteristics

$$(II.8) \sum_{t=t_B}^{t_B+4} \sum_{i=1}^{20} W_{yijt} r_{ijt} > L_{jy}$$

For  $j=1, 2, \dots, 20$   
 $y=t_B-5, \dots, t_B+4$

$$(II.9) \sum_{t=t_B}^{t_B+4} \sum_{i=1}^{20} W_{yijt} r_{ijt} \leq U_{jy}$$

For  $j=1, 2, \dots, 20$   
 $y=t_B, \dots, t_B+4$

### Selective Production

$$(II.10) x_{ijt} \geq M_{ijt} = \psi_{ijt} \sum_{j=1}^{20} x_{ijt}$$

For  $i=1, \dots, 20$   
 $j=1, \dots, 20$   
 $t=t_B, \dots, t_B+4$

$$(II.11) x_{ijt} \leq N_{ijt} = \beta_{ijt} \sum_{j=1}^{20} x_{ijt}$$

For  $i=1, \dots, 20$   
 $j=1, \dots, 20$   
 $t=t_B, \dots, t_B+4$

### Selective Recruitment

$$(II.12) F_{kijt} > \sigma_{kijt} r_{ijt}$$

For  $k=1, \dots, 20$   
 $i=1, \dots, 20$   
 $j=1, \dots, 20$   
 $t=t_B, \dots, t_B+4$

$$(II.13) F_{kijt} \leq \delta_{kijt} r_{ijt}$$

For  $k=1, \dots, 20$   
 $i=1, \dots, 20$   
 $j=1, \dots, 20$   
 $t=t_B, \dots, t_B+4$

Figure 3 (Continued)

### Variables, Coefficients and Right-Hand Sides

$x_{ijt}$	=	the number of commissioned officers of type $i$ produced by commissioning source $j$ for year $t$
$c_j$	=	production cost per source $j$ graduate
$c_i'$	=	training cost per officer type $i'$
$d_{i'ij}$	=	training program crossflows for entering officer type $i$ who leaves as officer type $i'$ from source $j$
$I$	=	estimated rate of inflation
$T_{ij}$	=	20-year turnover of officers of type $i$ from source $j$
$A_k$	=	average AFOQT score for individuals in supply pool $k$
$F_{kijt}$	=	the number of candidates taken from supply pool $k$ for type $i$ officers by source $j$ to meet year $t$ procurement requirements
$r_{ijt}$	=	the number of candidates of type $i$ entering source $j$ for year $t$ procurement requirements
$B_t$	=	total program budget for year $t$
$S_{ky}$	=	supply from supply pool $k$ available to meet recruitment requirements in year $y$
$\sigma_{kijt}$	=	indicator of the availability of supply pool $k$ in year $y$ to provide candidates of type $i$ to source $j$ for year $t$ procurement requirements
$\pi_{kt}$	=	proportion of the total requirement which should be filled with candidates from supply pool $k$ for year $t$ procurement requirements
$d_{i1ij}$	=	proportion of officers commissioned from source $j$ who enter training as type $i$ and emerge as type $i^1$
$\theta_{i1t}$	=	the specified procurement reports for year $t$ of type $i^1$ officers
$L_{jy}$	=	minimum number of candidates of all types entering source $j$ in year $y$
$U_{jy}$	=	maximum number of candidates of all types entering source $j$ in year $y$
$M_{ijt}$	=	minimum number of commissioned officers of type $i$ from source $j$ which should enter training to meet year $t$ procurement requirements
$N_{ijt}$	=	maximum number of commissioned officers of type $i$ from source $j$ which should enter training to meet year $t$ procurement requirements
$W_{yijt}$	=	indicator that recruitment must occur in year $y$ of officer type $i$ in source $j$ to meet procurement requirement in year $t$
$\psi_{ijt}$	=	minimum proportion of the commissioned officers of type $i$ entering training which should be filled by source $j$ to meet year $t$ procurement requirements
$\beta_{ijt}$	=	maximum proportion of the commissioned officers of type $i$ entering training which should be filled by source $j$ to meet year $t$ procurement requirements
$\alpha_{kijt}$	=	minimum proportion of the candidates which should be selected from supply pool $k$ of type $i$ entering source $j$ for year $t$ procurement requirements
$\delta_{kijt}$	=	maximum proportion of the candidates which should be selected from supply pool $k$ of type $i$ entering source $j$ for year $t$ procurement requirements

### Subscripts

$i$	=	officer type indicator
$j$	=	commissioning source indicator
$t$	=	year in which the procurement requirement occurs
$k$	=	supply pool indicator
$y$	=	year in which recruitment, training and other activities occur to satisfy procurement requirements

Figure 3 (Continued)

From Table 2, we see that there can be as many as 14,805 TOPOPS constraints and that there is a maximum of 6,100 structural variables. An additional 12,705 slack variables yield a maximum of 18,805 variables of all types.

Table 2. Magnitude of the TOPOPS Model

Constraining Relationship	Reference	No. of Constraints	Slack Variables
Quality Distribution	II.3	100	100
Program Budget	II.4	5	5
Supply	II.5	2,000	...
	II.6	200	200
Requirements	II.7	100	...
Policy and Operating Characteristics	II.8	200	200
	II.9	200	200
	II.10	2,000	2,000
	II.11	2,000	2,000
	II.12 } together	8,000	8,000
	II.13 }		
TOTALS		14,805	12,705
Number of Variables:			
Solution Variables	2,000		
Free Variables <sup>a</sup>	100		
Flow Variables	4,000		
Total Structural Variables	6,100		

<sup>a</sup>The free variables represent procurement by commissioning source with unconstrained supply; these are introduced into the solution only when existing supply pools are insufficient to meet the requirements.

### G. Interpretation of an Optimal Solution

In addition to the procurement mix specified by the solution variables, an optimal TOPOPS solution includes other important information. Slack variables convert inequality relationships to linear equations, required by the linear programming algorithm. The difference between the limited availability of a resource and the amount of that resource actually used is represented by a slack variable.

If an optimal solution satisfies a constraint as an equality, that is, if production is equal to the maximum or minimum amount allowed by the constraint, then the surplus variable for that constraint will have a value of zero. On the other hand, a non-zero slack variable in an optimal solution indicates that the constraint in which it appears is satisfied as an inequality; production is less than a maximum or greater than a minimum amount allowed by the constraint. Interpretations of the slack variables associated with TOPOPS constraints appear in Table 3.

## III. TOPOPS INPUT FORMS

### A. Introduction

The TOPOPS model was developed to provide an analytical tool for Air Force planners to assess the impact of alternative procurement decisions on the cost of procurement, as well as on the quality of officers entering the Air Force.

*Table 3. Interpretation of TOPOPS Slack Variables*

Constraining Relationship	Reference	Interpretation of non-zero slack variables
Quality Distribution	II.3	Number of candidates recruited from supply pool k in excess of the minimum proportion of the recruitment requirements specified.
Annual Budget	II.4	Amount by which expenditures by all agencies in year y to meet TOPOPS procurement requirements fall below the available portion of the annual budget.
Supply	II.5	None.
	II.6	Number of individuals in supply pool k for year t not recruited by an source.
Requirements	II.6	None.
Operating Characteristics	II.8	Number of commissioned officers of all types produced by source j in excess of its minimum production requirement for year t.
	II.9	Number of commissioned officers of all types representing the excess of capacity over production by source j for year t procurement requirements.
Selective Production	II.10	Number of commissioned officer of type i produced by source j in excess of its minimum training requirement for year t.
	II.11	Number of commissioned officers of type i representing the excess of capacity over production by source j for year t procurement requirements.
Selective Recruitment	II.12	Number of candidates of type i selected from supply pool k by source j in excess of recruitment for year procurement requirements.
	II.13	Number of candidates of type i which were not but could have been selected from supply pool k without exceeding the maximum portion of recruitment for year t requirements.

The purpose of this section is to provide instructions to the personnel planners on how to use the model.

1. Preparation of input
2. Edit criteria
3. Error conditions and corrective actions
4. Output from the model

#### **B. System Overview**

The TOPOPS program can be viewed as consisting of six processing steps.

1. Input form preparation by personnel planner
2. Input form conversion to machine readable format
3. Data initializer and edit
4. Model input matrix generation
5. Model execution
6. Output report generator

##### **Step 1:**

The personnel planner completes the data input forms providing the requirements, procurement agency and supply pool characteristics and selected constraints.

##### **Step 2:**

The user forms are converted to machine readable format (keypunched onto cards).

##### **Step 3:**

Input data cards, together with model run processing control cards, are assembled and form the input transaction stream for the model. Input data cards are read and all fields are edited. Examples of edit checks are:

1. Numeric field — are any nonnumeric characters included?
2. Do numeric values exceed the model specifications? (Example: More than twenty procurement agencies are specified because the model is designed for a maximum of twenty.)

All errors detected by the edit process are identified and printed as error messages. Editing of input transactions continues even if an error condition is detected. After all input transactions are processed, the system terminates if any fatal (nonsystem correctable) errors are found. This procedure assures that all input cards are read and edited for any one run.

##### **Step 4:**

The converted and edited user input is now used to generate the matrix transactions for the linear programming module of TOPOPS. The system is designed to tailor the model to the input; i.e., small input specifications will generate a small LP problem.

##### **Step 5:**

The TOPOPS model is now executed. It operates in two modes selected by the personnel planner on input Form 1:

1. Cost mode — the model minimizes production and training costs
2. Quality mode — the model maximizes officer entrance quality

Step 6:

Output data from the model is now assembled into six reports for management review and action. See Appendix A for sample input and output listings.

C. Management Input

The personnel planner specifies the problem on a set of forms. The forms are user-oriented while at the same time serve as the data conversion (keypunching) documents. Once in machine readable format, the system translates the user-specified problem into specifications for the model's linear programming algorithm.

The first card of the input data is the DATE card which contains a date for use on reports.

To facilitate control and an easy update procedure, each transaction resulting from the user prepared input forms contains the following (with the exception of the DATE card):

1. The TOPOPS form number
2. A record serial number
3. A record type code
4. The base year

All other information varies depending on the type form and record type.

---

	<u>Problem Definition: Part I</u>
Form 1	<u>Procurement Requirements</u>

With Form 1, the user specifies the procurement requirements and the type of officers to be procured. Further, the objective of the run is specified, either to minimize procurement and training cost or to maximize quality. The program budget data applicable to officer procurement is also indicated. There are four types of records within Form 1, each record type is explained as follows:

*Record Type 1*

The officer type can be selected, the model is designed to handle up to five types of officers. The officer descriptor can be specified up to a maximum of eighteen characters. Procurement requirements can be specified for a 5-year period from base year to base year +4. The values must be numeric.

*Record Type 2*

Specifies to the model what constraints (II.3 through II.13, Figure 3) the personnel planner wants to use. Enter a one for each constraint selected.

*Record Type 3*

Specifies that the objective is to minimize cost or to maximize quality. The personnel analyst enters either "COST" or "QUAL" in the space provided.

*Record Type 4*

Specify the program budget (in thousands) available to TOPOPS and an inflation rate as a percent. The program budget can be specified for the base year through the base year plus 4.

## PROBLEM DEFINITION: PART I

### PROCUREMENT REQUIREMENTS

1  
TOPOPS FORM 1

BASE YEAR

77 80

RECORD SERIAL #	RECORD TYPE	RECORD OFFICER TYPE
2		1
		2
		3
		4
		5
		6
		7
		8
		9
		10
		11
		12
		13
		14
		15
		16
		17
		18
		19
		20

[illegible]

## PROBLEM DEFINITION: PART I

BASE YEAR

77 80

1  
TOPOPS FORM 1

RECORD SERIAL #	RECORD TYPE
--------------------	----------------

## MODEL RUN OPTION

## OBJECTIVE

6 5 4 3 2

ENTER 'COST' OR 'QUAL'

RECORD RECORD

SERIAL #	TYPE	YEAR
2		
5		
6	4	5
	4	6
	4	7
	4	8
	4	9

BASE YEAR

INFLATION  
RATE

33	35
----	----

**PROGRAM BUDGET  
IN \$1000**

46	
55	

---

Data Base: Part I

Form 2

Procurement Agency Characteristics

Complete both pages of Form 2 for each agency. With Form 2, the user describes the characteristics of the procurement agencies. The model is designed for up to twenty agencies. There are four record types within Form 2: Each record type is explained as follows:

*Record Type 1*

All entries except the agency descriptor must be numeric. Enter the agency code. It is numeric and has a value from zero to nineteen. Enter an agency descriptor up to eighteen characters. Enter pay and allowance and other cost per graduate. Enter program (production) length of this agency (in years).

*Record Type 2 (Second Page)*

All entries must be numeric. Enter information for officer types selected. Enter agency code. Enter agency crossflow percentage. The officer type that enters production is indicated by column and the officer type that completes production is indicated by row. Enter turnover rate by officer type of this agency.

*Record Type 3*

All entries must be numeric. Enter agency code. Enter minimum production limit quantity of this agency for the base year minus five through base year minus one on Part 1 of Record Type 3. Enter minimum production limit quantity of this agency for the base year through the base year plus four on Part 2 of the Record Type 3.

*Record Type 4*

All entries must be numeric. Enter agency code. Enter maximum production limit quantity of this agency for the base year minus five through base year minus one on Part 1 of Record Type 4. Enter maximum production limit quantity of this agency for the base year through this base year plus four on Part 2 of Record Type 4.



30

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Form 3

Data Base: Part II  
Manpower Supply

One page of Form 3 must be completed for each manpower supply pool selected. With Form 3, the user describes the characteristics of the supply pools. Up to twenty supply pools can be specified. There are three record types within Form 3, each record type is explained as follows:

*Record Type 1*

All entries, except the supply pool descriptor, must be numeric. Enter supply pool code (01 through 20). Enter supply pool descriptor (up to 18 characters). Enter AFOQT for this supply pool. Enter the type of officers that this pool can supply (by entering 1 in the appropriate column).

*Record Type 2*

All entries must be numeric. Enter the supply pool code. For a 5-year period (base year minus five through base year plus four) enter the quantity available from this supply pool. For the base year through the base year plus four, enter the proportion of the total procurement requirements that this pool should supply.

*Record Type 3*

All entries must be numeric. Enter the supply pool code. Enter a 1 in the appropriate column to indicate that the supply pool can supply the agency.

TOPOPS FORM		TOPOPS SPECIFICATIONS		BASE YEAR	
1		3		77 80	
RECORD SERIAL #	RECORD TYPE	DATA BASE: PART II		MANPOWER SUPPLY	
2	5	1			
SUPPLY POOL		POOL DESCRIPTOR		AFOQT	
11 12		13		30 31 35	
1		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20		56 75	
TYPE OFFICERS FROM POOL		QUANTITY AVAILABLE		PROP. OF REQ. FROM THIS POOL	
YEAR		31 35		56 58	
2	5	11 12		56 58	
2	6	0 1 2 3 4 5 6 7 8 9		56 58	
2	6	-5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9		56 58	
2	6	Base Yr		56 58	
2	6	+1 +2 +3 +4		56 58	
2	6	2		56 58	
2	6	3		56 58	
2	6	4		56 58	
2	6	5		56 58	
2	6	6		56 58	
2	6	7		56 58	
2	6	8		56 58	
2	6	9		56 58	
2	6	10		56 58	
2	6	11		56 58	
2	6	12		56 58	
2	6	13		56 58	
2	6	14		56 58	
2	6	15		56 58	
2	6	16		56 58	
2	6	17		56 58	
2	6	18		56 58	
2	6	19		56 58	
2	6	20		56 58	
2	6	21		56 58	
2	6	22		56 58	
2	6	23		56 58	
2	6	24		56 58	
2	6	25		56 58	
2	6	26		56 58	
2	6	27		56 58	
2	6	28		56 58	
2	6	29		56 58	
2	6	30		56 58	
2	6	31		56 58	
2	6	32		56 58	
2	6	33		56 58	
2	6	34		56 58	
2	6	35		56 58	
2	6	36		56 58	
2	6	37		56 58	
2	6	38		56 58	
2	6	39		56 58	
2	6	40		56 58	
2	6	41		56 58	
2	6	42		56 58	
2	6	43		56 58	
2	6	44		56 58	
2	6	45		56 58	
2	6	46		56 58	
2	6	47		56 58	
2	6	48		56 58	
2	6	49		56 58	
2	6	50		56 58	
2	6	51		56 58	
2	6	52		56 58	
2	6	53		56 58	
2	6	54		56 58	
2	6	55		56 58	
2	6	56		56 58	
2	6	57		56 58	
2	6	58		56 58	
2	6	59		56 58	
2	6	60		56 58	
2	6	61		56 58	
2	6	62		56 58	
2	6	63		56 58	
2	6	64		56 58	
2	6	65		56 58	
2	6	66		56 58	
2	6	67		56 58	
2	6	68		56 58	
2	6	69		56 58	
2	6	70		56 58	
2	6	71		56 58	
2	6	72		56 58	
2	6	73		56 58	
2	6	74		56 58	
2	6	75		56 58	
2	6	76		56 58	
2	6	77		56 58	
2	6	78		56 58	
2	6	79		56 58	
2	6	80		56 58	
2	6	81		56 58	
2	6	82		56 58	
2	6	83		56 58	
2	6	84		56 58	
2	6	85		56 58	
2	6	86		56 58	
2	6	87		56 58	
2	6	88		56 58	
2	6	89		56 58	
2	6	90		56 58	
2	6	91		56 58	
2	6	92		56 58	
2	6	93		56 58	
2	6	94		56 58	
2	6	95		56 58	
2	6	96		56 58	
2	6	97		56 58	
2	6	98		56 58	
2	6	99		56 58	
2	6	100		56 58	

---

**Form 4**

**Data Base: Part III**  
**Training Requirements**

With Form 4, the user describes the characteristics of the training agencies. Up to twenty training agencies can be specified. Two record types are used.

*Record Type 1*

All entries except the Training Agency Descriptor must be numeric. Enter training agency descriptor, up to eighteen characters. Enter training production time (in years). Enter training program cost per graduate.

*Record Type 2*

All entries are numeric, and one page must be filled out for each procurement agency. This record ties attrition and crossflows in training to commissioning source. Enter the agency code. Enter the training crossflow percentage. Columns represent entering officer type and rows indicate leaving officer type.



TOPOPS FORM <sup>1</sup> 4

BASE YEAR 77 80

TOPOPS SPECIFICATIONS  
DATA BASE: PART III

TRAINING CHARACTERISTICS  
SCHOOL TRAINING CROSSFLOW  
ENTERING OFFICER TYPE

RECORD SERIAL #

2 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

OFFICER TYPE

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

AGENCY CODE

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Form 5

Data Base: Part IV  
Network Definition

With Form 5, the user describes the selective production by procurement agencies to meet requirements and the selection recruitment from supply pools. Form 5 consists of four pages and contains four record types; each record type is explained as follows:

*Record Type 1*

Describes the minimum proportion of the total procurement requirements for officers of type i that agency j must produce to meet requirements. All entries must be numeric (percentages). Enter officer type, numeric from one to twenty. Enter the agency code, numeric from zero to nineteen. Enter the minimum production proportion for the base year through the base year plus four requirements.

*Record Type 2*

Describes the maximum proportion of the total procurement requirement for officers of type i that agency j must produce to meet requirements. All entries must be numeric. Enter officer type, numeric from one to twenty. Enter the agency code, numeric from zero to nineteen. Enter the maximum production proportion for the base year through the base year plus four requirements.

*Record Type 3*

Describes the minimum number of officers of type i that agency j must recruit from supply pool k to meet requirements. Enter officer type, numeric from one to twenty. Enter the agency code, numeric from zero to nineteen. Enter the supply pool code, numeric 01 to 20. Enter the minimum number of officers that must be recruited from the supply pool for base year through base year plus four.

*Record Type 4*

Describes the maximum number of officers of type i that agency j may recruit from supply pool k to meet requirements. Each officer type numeric from one to twenty. Enter the agency code, numeric from zero to nineteen. Enter the supply pool code, numeric from 01 to 20. Enter the maximum number of officers that may be recruited from the supply pool for base year through base year plus four.





**BASE YEAR**

**TOPOPS SPECIFICATIONS**  
**DATA BASE: PART IV**  
**NETWORK DEFINITION**

—

**5**  
**TOPOPS FORM**

[illegible]

# TOPOPS SPECIFICATIONS

DATA BASE: PART IV

NETWORK DEFINITION

1

TOPOPS FORM 5

77 80

BASE YEAR

RECORD SERIAL #	RECORD TYPE	OFFICER TYPE	COMM. SOURCE	SUPPLY POOL	BASE YEAR	SUPPLY SELECTIVE REQUIREMENT MAXIMUMS				
						36	41	46	51	55
1	4	7	9	11	31					
2	4	7	9	11	31					
3	4	7	9	11	31					
4	4	7	9	11	31					
5	4	7	9	11	31					
6	4	7	9	11	31					
7	4	7	9	11	31					
8	4	7	9	11	31					
9	4	7	9	11	31					
10	4	7	9	11	31					
11	4	7	9	11	31					
12	4	7	9	11	31					
13	4	7	9	11	31					
14	4	7	9	11	31					
15	4	7	9	11	31					
16	4	7	9	11	31					
17	4	7	9	11	31					
18	4	7	9	11	31					
19	4	7	9	11	31					
20	4	7	9	11	31					
21	4	7	9	11	31					
22	4	7	9	11	31					
23	4	7	9	11	31					
24	4	7	9	11	31					
25	4	7	9	11	31					
26	4	7	9	11	31					
27	4	7	9	11	31					
28	4	7	9	11	31					
29	4	7	9	11	31					
30	4	7	9	11	31					
31	4	7	9	11	31					
32	4	7	9	11	31					
33	4	7	9	11	31					
34	4	7	9	11	31					
35	4	7	9	11	31					
36	4	7	9	11	31					
37	4	7	9	11	31					
38	4	7	9	11	31					
39	4	7	9	11	31					
40	4	7	9	11	31					
41	4	7	9	11	31					
42	4	7	9	11	31					
43	4	7	9	11	31					
44	4	7	9	11	31					
45	4	7	9	11	31					
46	4	7	9	11	31					
47	4	7	9	11	31					
48	4	7	9	11	31					
49	4	7	9	11	31					
50	4	7	9	11	31					
51	4	7	9	11	31					
52	4	7	9	11	31					
53	4	7	9	11	31					
54	4	7	9	11	31					
55	4	7	9	11	31					
56	4	7	9	11	31					
57	4	7	9	11	31					
58	4	7	9	11	31					
59	4	7	9	11	31					
60	4	7	9	11	31					
61	4	7	9	11	31					
62	4	7	9	11	31					
63	4	7	9	11	31					
64	4	7	9	11	31					
65	4	7	9	11	31					
66	4	7	9	11	31					
67	4	7	9	11	31					
68	4	7	9	11	31					
69	4	7	9	11	31					
70	4	7	9	11	31					
71	4	7	9	11	31					
72	4	7	9	11	31					
73	4	7	9	11	31					
74	4	7	9	11	31					
75	4	7	9	11	31					
76	4	7	9	11	31					
77	4	7	9	11	31					
78	4	7	9	11	31					
79	4	7	9	11	31					
80	4	7	9	11	31					
81	4	7	9	11	31					
82	4	7	9	11	31					
83	4	7	9	11	31					
84	4	7	9	11	31					
85	4	7	9	11	31					
86	4	7	9	11	31					
87	4	7	9	11	31					
88	4	7	9	11	31					
89	4	7	9	11	31					
90	4	7	9	11	31					
91	4	7	9	11	31					
92	4	7	9	11	31					
93	4	7	9	11	31					
94	4	7	9	11	31					
95	4	7	9	11	31					
96	4	7	9	11	31					
97	4	7	9	11	31					
98	4	7	9	11	31					
99	4	7	9	11	31					
100	4	7	9	11	31					

#### REFERENCES

Akman, A., & Nordhauser, F. *A conceptual view of the officer procurement model (TOPOPS)*. AFHRL-TR-73-73, AD-A001 577. Lackland AFB, TX: Manpower and Personnel Systems Division, Air Force Human Resources Laboratory, July 1974.

Akman, A., Nordhauser, F., & Roach, J.F. *A technical description of the officer procurement model (TOPOPS)*. AFHRL-TR-73-76, AD-A000 052. Lackland AFB, TX: Manpower and Personnel Systems Division, Air Force Human Resources Laboratory, July 1974.

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#### APPENDIX A: SAMPLE FORMS AND INPUT/OUTPUT LISTINGS

This appendix presents a set of input records for a TOPOPS run. The data are input so that only constraints II.3 through II.7 (Figure 3) will be activated. This will demonstrate the significant features of the input forms and data initializer write-out. Additionally, this appendix also shows output, based on this specific input, from the reports generator module.

## PROCUREMENT REQUIREMENTS

1  
TOPOPS FORM 1

BASE YEAR  
77 80  
1970

RECORD SERIAL #		RECORD TYPE		OFFICER TYPE	
2	5	6	7	8	
		1			1
		1			2
		1			3
		1			4
		1			5
		1			6
		1			7
		1			8
		1			9
		1			10
		1			11
		1			12
		1			13
		1			14
		1			15
		1			16
		1			17
		1			18
		1			19
		1			20

[illegible]

TOPOPS SPECIFICATIONS  
 PROBLEM DEFINITION: PART I  
 PROCUREMENT REQUIREMENTS

BASE YEAR 77 78 79 80  
 1 9 7 0

TOPOPS FORM 1

RECORD SERIAL #

2 5 6 2

MODEL RUN OPTION

31 41

32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

OBJECTIVE

2 5 6 3

ENTER 'COST' OR 'QUAL'

C O S T

RECORD SERIAL #

2 5 6 9 10

4 4 4 4 4 5 6 7 8 9

BASE YEAR

+1 +2 +3 +4

PROGRAM BUDGET  
 IN \$1000

46 55

INFLATION  
 RATE

33 35



TOPOPS FORM 1

TOPOPS SPECIFICATIONS

DATA BASE: PART I

BASE YEAR

77 80

1970

PROCUREMENT AGENCY CHARACTERISTICS

AGENCY CROSSFLOW  
ENTERING OFFICER TYPE

TURN  
OVER

73

OFFICER  
TYPE  
PRODUCED

AGENCY  
CODE

RECORD SERIAL #	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TURN OVER
2		2	1														10
		2	2														10
		2	3														10
		2	4														10
		2	5														10
		2	6														10
		2	7														10
		2	8														10
		2	9														10
		2	10														10
		2	11														10
		2	12														10
		2	13														10
		2	14														10
		2	15														10
		2	16														10
		2	17														10
		2	18														10
		2	19														10
		2	20														10

77 80

BASE YEAR 1972

TOPOPS SPECIFICATIONS

DATA BASE: PART I

PROCUREMENT AGENCY CHARACTERISTICS

TOPOPS FORM 1 2

RECORD SERIAL #	2	5	6	1	9	10	1	AGENCY CODE	13	AGENCY DESCRIPTOR	30	31	35	36	40	PROG LNGTH

MINIMUM PRODUCTION LIMIT

PART	2	5	6	7	8	9	10	31	-5	-4	-3	-2	-1

MAXIMUM PRODUCTION LIMIT

PART	2	5	6	7	8	9	10	31	-5	-4	-3	-2	-1

77 80  
1970

BASE YEAR

TOPOPS SPECIFICATIONS  
DATA BASE: PART I

PROCUREMENT AGENCY CHARACTERISTICS

RECORD SERIAL #	OFFICER TYPE	AGENCY CODE	AGENCY CROSSFLOW ENTERING OFFICER TYPE																						TURN OVER
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	70	73	
2	2	1	99																						10
	2	2	99																						10
	2	3	99																						10
	2	4	99																						10
	2	5	99																						10
	2	6	99																						10
	2	7	99																						10
	2	8	99																						10
	2	9	99																						10
	2	10	99																						10
	2	11	99																						10
	2	12	99																						10
	2	13	99																						10
	2	14	99																						10
	2	15	99																						10
	2	16	99																						10
	2	17	99																						10
	2	18	99																						10
	2	19	99																						10
	2	20	99																						10

TOPOPS FORM <sup>1</sup>  
 2

TOPOPS SPECIFICATIONS  
 DATA BASE: PART I

PROCUREMENT AGENCY CHARACTERISTICS

BASE YEAR 77 80  
 1976

RECORD SERIAL #	RECORD TYPE	AGENCY CODE	AGENCY DESCRIPTOR	P & A COST	OTHER COST	PROG LNTH
2	5	6	13	30	35	59
		1	AGENCY 2	10376		1

MINIMUM PRODUCTION LIMIT

PART	5	6	7	8	9	10	31	-5	-4	-3	-2	-1
2		3	1									
		3	2									

MAXIMUM PRODUCTION LIMIT

PART	5	6	7	8	9	10	31	-5	-4	-3	-2	-1
2		4	1									
		4	2									

TOPOPS FORM 1

TOPOPS SPECIFICATIONS

DATA BASE: PART I

PROCUREMENT AGENCY CHARACTERISTICS

OFFICER TYPE AGENCY CODE

AGENCY CROSSFLOW ENTERING OFFICER TYPE

TURN OVER

77 \* 80

1970

TOPOPS FORM 2

RECORD SERIAL #

2	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	73
		2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	10
		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	10
		2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	10
		2	4	2	2	2	2	2	2	2	2	2	2	2	2	2	10
		2	5	2	2	2	2	2	2	2	2	2	2	2	2	2	10
		2	6	2	2	2	2	2	2	2	2	2	2	2	2	2	10
		2	7	2	2	2	2	2	2	2	2	2	2	2	2	2	10
		2	8	2	2	2	2	2	2	2	2	2	2	2	2	2	10
		2	9	2	2	2	2	2	2	2	2	2	2	2	2	2	10
		2	10	2	2	2	2	2	2	2	2	2	2	2	2	2	10
		2	11	2	2	2	2	2	2	2	2	2	2	2	2	2	10
		2	12	2	2	2	2	2	2	2	2	2	2	2	2	2	10
		2	13	2	2	2	2	2	2	2	2	2	2	2	2	2	10
		2	14	2	2	2	2	2	2	2	2	2	2	2	2	2	10
		2	15	2	2	2	2	2	2	2	2	2	2	2	2	2	10
		2	16	2	2	2	2	2	2	2	2	2	2	2	2	2	10
		2	17	2	2	2	2	2	2	2	2	2	2	2	2	2	10
		2	18	2	2	2	2	2	2	2	2	2	2	2	2	2	10
		2	19	2	2	2	2	2	2	2	2	2	2	2	2	2	10
		2	20	2	2	2	2	2	2	2	2	2	2	2	2	2	10



TOPOPS FORM 1

TOPOPS SPECIFICATIONS  
DATA BASE: PART I

77 80  
1970

PROCUREMENT AGENCY CHARACTERISTICS

AGENCY CROSSFLOW  
ENTERING OFFICER TYPE

OFFICER  
TYPE  
PRODUCED CODE

RECORD  
SERIAL #

TURN  
OVER  
73

2	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	70	73
		2	1	3	70													10
		2	2	3	70													10
		2	3	3														10
		2	4	3														10
		2	5	3														10
		2	6	3														10
		2	7	3														10
		2	8	3														10
		2	9	3														10
		2	10	3														10
		2	11	3														10
		2	12	3														10
		2	13	3														10
		2	14	3														10
		2	15	3														10
		2	16	3														10
		2	17	3														10
		2	18	3														10
		2	19	3														10
		2	20	3														10

TOPOPS FORM 1

TOPOPS SPECIFICATIONS  
DATA BASE: PART I

PROCUREMENT AGENCY CHARACTERISTICS

RECORD  
SERIAL #

RECORD  
TYPE

AGENCY  
CODE

AGENCY DESCRIPTOR

P & A COST

OTHER COST

PROG  
LNTH

TOPOPS FORM 2

BASE YEAR 1970

2 5 6 13  
AGENCY 4

30 31 35 36 40  
66890

59 61  
7

MINIMUM PRODUCTION LIMIT

PART 5 6 7 8 9 10 31 -5 -4 -3 -2 -1  
3 1  
3 2  
BASE YEAR +1 +2 +3 +4

MAXIMUM PRODUCTION LIMIT

2 5 6 7 8 9 10 31 -5 -4 -3 -2 -1  
4 1  
4 2  
BASE YEAR +1 +2 +3 +4

TOPOPS FORM <sup>1</sup>  
 2

TOPOPS SPECIFICATIONS  
 DATA BASE: PART I

BASE YEAR

77 80

1970

PROCUREMENT AGENCY CHARACTERISTICS

AGENCY CROSSFLOW  
 ENTERING OFFICER TYPE

OFFICER  
 TYPE AGENCY  
 PRODUCED CODE

RECORD  
 SERIAL #

TURIN  
 OVER

2	5	6	7	8	9	10	13	1	16	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	73
		2	1	4	68																								10
		2	2	4	68																								10
		2	3	4	68																								10
		2	4	4	68																								10
		2	5	4	68																								10
		2	6	4	68																								10
		2	7	4	68																								10
		2	8	4	68																								10
		2	9	4	68																								10
		2	10	4	68																								10
		2	11	4	68																								10
		2	12	4	68																								10
		2	13	4	68																								10
		2	14	4	68																								10
		2	15	4	68																								10
		2	16	4	68																								10
		2	17	4	68																								10
		2	18	4	68																								10
		2	19	4	68																								10
		2	20	4	68																								10





TOPOPS FORM 1 3

TOPOPS SPECIFICATIONS  
DATA BASE: PART II  
MANPOWER SUPPLY

BASE YEAR 77 80 1970

RECORD SERIAL # 2  
RECORD TYPE 6  
SUPPLY POOL 11 12  
03

POOL 3  
POOL DESCRIPTOR  
AFOQT 35  
90

TYPE OFFICERS FROM POOL  
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

QUANTITY AVAILABLE		PROP. OF REQ. FROM THIS POOL	
31	35	56	58
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	10	10
11	11	11	11
12	12	12	12
13	13	13	13
14	14	14	14
15	15	15	15
16	16	16	16
17	17	17	17
18	18	18	18
19	19	19	19
20	20	20	20
21	21	21	21
22	22	22	22
23	23	23	23
24	24	24	24
25	25	25	25
26	26	26	26
27	27	27	27
28	28	28	28
29	29	29	29
30	30	30	30
31	31	31	31
32	32	32	32
33	33	33	33
34	34	34	34
35	35	35	35
36	36	36	36
37	37	37	37
38	38	38	38
39	39	39	39
40	40	40	40
41	41	41	41
42	42	42	42
43	43	43	43
44	44	44	44
45	45	45	45
46	46	46	46
47	47	47	47
48	48	48	48
49	49	49	49
50	50	50	50
51	51	51	51
52	52	52	52
53	53	53	53
54	54	54	54
55	55	55	55
56	56	56	56
57	57	57	57
58	58	58	58
59	59	59	59
60	60	60	60
61	61	61	61
62	62	62	62
63	63	63	63
64	64	64	64
65	65	65	65
66	66	66	66
67	67	67	67
68	68	68	68
69	69	69	69
70	70	70	70
71	71	71	71
72	72	72	72
73	73	73	73
74	74	74	74
75	75	75	75
76	76	76	76
77	77	77	77
78	78	78	78
79	79	79	79
80	80	80	80
81	81	81	81
82	82	82	82
83	83	83	83
84	84	84	84
85	85	85	85
86	86	86	86
87	87	87	87
88	88	88	88
89	89	89	89
90	90	90	90
91	91	91	91
92	92	92	92
93	93	93	93
94	94	94	94
95	95	95	95
96	96	96	96
97	97	97	97
98	98	98	98
99	99	99	99
100	100	100	100

RECORD SERIAL # 2  
RECORD TYPE 6  
POOL 11 12  
03





[illegible]

TOPOPS FORM 1 3

TOPOPS SPECIFICATIONS  
DATA BASE: PART II  
MANPOWER SUPPLY

77

80

BASE YEAR

1970

RECORD SERIAL # 2  
RECORD TYPE 6  
SUPPLY POOL 11 12  
POOL DESCRIPTOR 13  
AFOQT 30 31 35

50

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

TYPE OFFICERS FROM POOL

QUANTITY AVAILABLE

31 35

YEAR 9 10 11 12  
0 -5  
1 -4  
2 -3  
3 -2  
4 -1  
5 0  
6 +1  
7 +2  
8 +3  
9 +4

PROP. OF REQ. FROM THIS POOL

56 58

RECORD SERIAL # 2  
RECORD TYPE 6  
POOL 11 12  
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

TOPOPS FORM		TOPOPS SPECIFICATIONS		BASE YEAR	
1		DATA BASE: PART II		77 80	
3		MANPOWER SUPPLY		1970	

RECORD SERIAL #	RECORD TYPE	SUPPLY POOL	POOL DESCRIPTOR	AFOQT
2	5	11 12	13	35
		08	pool 8	70

TYPE OFFICERS FROM POOL		QUANTITY AVAILABLE		PROP OF REQ FROM THIS POOL																
56		31 35		56 58																
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	75
/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

YEAR	9	10	11	12
2	0	1	2	3
5	-5	-4	-3	-2
6	-1	0	1	2
7	3	4	5	6
8	7	8	9	10
9	11	12	13	14

RECORD SERIAL #	RECORD TYPE	POOL	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2	5	11 12	31																			
		08																				

TOPOPS FORM 1 3

BASE YEAR 77 80

TOPOPS SPECIFICATIONS

DATA BASE: PART II

MANPOWER SUPPLY

RECORD SERIAL # 2 5 6 1

POOL DESCRIPTOR 13 POOL 9

TYPE OFFICERS FROM POOL 56 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 7c

QUANTITY AVAILABLE

YEAR 9 10 11 12

2	0	-5
2	1	-4
2	2	-3
2	3	-2
2	4	-1
2	5	Base Yr
2	6	+1
2	7	+2
2	8	+3
2	9	+4

QUANTITY AVAILABLE 31 35

5	0	0
---	---	---

PROP. OF 11111  
FROM THIS P. 1111  
56 63

1	1	1	1	1
---	---	---	---	---

RECORD SERIAL # 2 5 6 3

POOL 11 12 0 9

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 31 50

TOPOPS FORM 1

BASE YEAR 77 80

1970

TOPOPS SPECIFICATIONS  
DATA BASE: PART III  
TRAINING CHARACTERISTICS

RECORD SERIAL #	OFFICER RECORD TYPE	TYPE PRODUCED	TRAINING AGENCY DESCRIPTOR	TRAINING TIME			COST
				30	40	45	
1	1	1	SCH00L 1		1		86,600
2	1	2	SCH00L 2		1		20,000
3	1	3	SCH00L 3		1		50,000
4	1	4	SCH00L 4		1		12,000
5	1	5	SCH00L 5		1		41,000
6	1	6	SCH00L 6		1		19,000
7	1	7	SCH00L 7		1		30,000
8	1	8	SCH00L 8		1		9,000
9	1	9	SCH00L 9		1		9,000
10	1	10	SCH00L 10		1		29,000
11	1	11	SCH00L 11		1		33,000
12	1	12	SCH00L 12		1		40,000
13	1	13	SCH00L 13		1		24,000
14	1	14	SCH00L 14		1		34,000
15	1	15	SCH00L 15		1		49,000
16	1	16	SCH00L 16		1		30,000
17	1	17	SCH00L 17		1		20,000
18	1	18	SCH00L 18		1		28,000
19	1	19	SCH00L 19		1		38,000
20	1	20	SCH00L 20		1		9,000

## TOPOPS SPECIFICATIONS

DATA BASE: PART III

## TRAINING CHARACTERISTICS

SCHOOL TRAINING CROSSFLOW  
ENTERING OFFICER TYPE

BASE YEAR 77 80 1970

[illegible]

TOPOPS FORM <sup>1</sup>4

TOPOPS SPECIFICATIONS  
DATA BASE: PART III

77 80  
BASE YEAR 1970

TRAINING CHARACTERISTICS  
SCHOOL TRAINING CROSSFLOW  
ENTERING OFFICER TYPE

OFFICER  
TYPE AGENCY  
CODE

RECORD  
SERIAL #

2	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
		2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
		2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
		2	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		2	5	5	5	5	5	5	5	5	5	5	5	5	5	5
		2	6	6	6	6	6	6	6	6	6	6	6	6	6	6
		2	7	7	7	7	7	7	7	7	7	7	7	7	7	7
		2	8	8	8	8	8	8	8	8	8	8	8	8	8	8
		2	9	9	9	9	9	9	9	9	9	9	9	9	9	9
		2	10	10	10	10	10	10	10	10	10	10	10	10	10	10
		2	11	11	11	11	11	11	11	11	11	11	11	11	11	11
		2	12	12	12	12	12	12	12	12	12	12	12	12	12	12
		2	13	13	13	13	13	13	13	13	13	13	13	13	13	13
		2	14	14	14	14	14	14	14	14	14	14	14	14	14	14
		2	15	15	15	15	15	15	15	15	15	15	15	15	15	15
		2	16	16	16	16	16	16	16	16	16	16	16	16	16	16
		2	17	17	17	17	17	17	17	17	17	17	17	17	17	17
		2	18	18	18	18	18	18	18	18	18	18	18	18	18	18
		2	19	19	19	19	19	19	19	19	19	19	19	19	19	19
		2	20	20	20	20	20	20	20	20	20	20	20	20	20	20

TOPOPS FORM <sup>1</sup>4 BASE YEAR 1970

TOPOPS SPECIFICATIONS  
DATA BASE: PART III

TRAINING CHARACTERISTICS  
SCHOOL TRAINING CROSSFLOW  
ENTERING OFFICER TYPE

RECORD SERIAL #  
OFFICER TYPE  
AGENCY CODE

2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20



TOPOPS FORM <sup>1</sup>4

TOPOPS SPECIFICATIONS  
DATA BASE: PART III

BASE YEAR 77 80

TRAINING CHARACTERISTICS  
SCHOOL TRAINING CROSSFLOW  
ENTERING OFFICER TYPE

RECORD  
SERIAL #

OFFICER  
TYPE

PRODUCED

AGENCY  
CODE

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60

61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120

121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140

141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160

161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180

181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200

201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220

221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240

241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260

261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280

281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300

301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320

321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340

341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360

361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380

381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400

401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420

421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440

441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460

461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480

481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500

501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520

521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540

541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560

561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580

581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600

601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620

621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640

AIR FORCE HUMAN RESOURCE LABORATORY  
PERSONNEL RESEARCH DIVISION

TOPOPS OFFICER PROCUREMENT  
ANNUAL PROCUREMENT SCHEDULE

OBJECTIVE: MINIMIZE COST

DATE OF REPORT: 13 NOVEMBER

PROCUREMENT REQUIREMENTS

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
OT 1						100				
OT 2						50				
OT 3						50				
OT 4						100				
OT 5						100				
OT 6						100				
OT 7						100				
OT 8						100				
OT 9						100				
OT 10						100				
OT 11						50				
OT 12						50				
OT 13						50				
OT 14						50				
OT 15						50				
OT 16						50				
OT 17						50				
OT 18						50				
OT 19						50				
OT 20						50				
TOTAL						1400.				

TRAINING REQUIREMENTS

OT 1	0.	0.	0.	0.	0.	111.
OT 2	0.	0.	0.	0.	0.	56.
OT 3	0.	0.	0.	0.	0.	52.



0T19  
0T20

**AGENCY I**

OT 1 OT 2 OT 3 OT 4 OT 5 OT 6 OT 7 OT 8 OT 9 OT 10 OT 11 OT 12 OT 13 OT 14 OT 15 OT 16 OT 17 OT 18 OT 19 OT 20

AGENCY 2  
OT 1

AIR FORCE HUMAN RESOURCE LABORATORY  
PERSONNEL RESEARCH DIVISION

TOPOPS OFFICER PROCUREMENT  
ANNUAL PROCUREMENT SCHEDULE

DATE OF REPORT: 13 NOVEMBER

OBJECTIVE:	MINIMIZE COST
1972	1973
1974	

RECRUITMENT REQUIREMENTS (CONTINUED)

AGENCY 2

0T 2 0T 3 0T 4 0T 5 0T 6 0T 7 0T 8 0T 9 0T10 0T11 0T12 0T13 0T14 0T15 0T16





AGENCY 0  
AGENCY 1  
AGENCY 2  
AGENCY 3  
AGENCY 4  
TOTAL

12.7  
10.9  
8.7  
8.8  
24.4  
65.6

.0  
.0  
.0  
.0  
.0  
.0

.0  
.0  
.0  
.0  
.0  
.0

12.7  
10.9  
8.7  
8.8  
24.4  
65.6

AIR FORCE HUMAN RESOURCE LABORATORY  
PERSONNEL RESEARCH DIVISION

TOPOPS OFFICER PROCUREMENT  
COST ANALYSIS

OBJECTIVE: MINIMIZE COST

DATE OF REPORT: 13 NOVEMBER

I. COST PER OFFICER

PAY AND ALLOWANCES OTHER COSTS TOTAL COSTS

AGENCY 0  
AGENCY 1  
AGENCY 2  
AGENCY 3  
AGENCY 4  
AVERAGE

4540  
23000  
10370  
9250  
66890  
17919.

0  
0  
0  
0  
0  
0.

4540  
23000  
10370  
9250  
66890  
19919.

II. COST PERCENTAGES

1970 1971 1972 1973 1974 TOTAL

AGENCY 0  
AGENCY 1  
AGENCY 2  
AGENCY 3  
AGENCY 4  
TOTAL

19.4  
16.6  
13.3  
13.4  
37.2  
100.0

.0  
.0  
.0  
.0  
.0  
.0

.0  
.0  
.0  
.0  
.0  
.0

19.4  
16.6  
13.3  
13.4  
37.2  
100.0

III. COST PERCENTAGES (WITH TURNOVER)

1970 1971 1972 1973 1974 TOTAL

AGENCY 0	19.4	.0	.0	.0	.0	19.4
AGENCY 1	16.6	.0	.0	.0	.0	16.6
AGENCY 2	13.3	.0	.0	.0	.0	13.3
AGENCY 3	13.4	.0	.0	.0	.0	13.4
AGENCY 4	37.2	.0	.0	.0	.0	37.2
TOTAL	100.0	.0	.0	.0	.0	100.0

AIR FORCE HUMAN RESOURCE LABORATORY  
PERSONNEL RESEARCH DIVISION

TOPOPS OFFICER PROCUREMENT  
OFFICER QUALITY PROFILE

DATE OF REPORT: 13 NOVEMBER

OBJECTIVE: MINIMIZE COST

I. AVERAGE QUALITY

	1970	1971	1972	1973	1974	AVERAGE
AGENCY 0	60.	0.	0.	0.	0.	60.
AGENCY 1	90.	0.	0.	0.	0.	90.
AGENCY 2	60.	0.	0.	0.	0.	60.
AGENCY 3	60.	0.	0.	0.	0.	60.
AGENCY 4	90.	0.	0.	0.	0.	90.
AVERAGE	70.	0.	0.	0.	0.	70.

II. SOURCE OF SUPPLY (1970-74)

AGENCY-0	AGENCY-1	AGENCY-2	AGENCY-3	AGENCY-4	TOTAL
0	1	2	3	4	
0	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
TOTAL	0	0	0	0	0



AGENCY 4	0.	0.	0.	0.	0.	0.	0.
OT 4							
AGENCY 0	0.	0.	0.	0.	0.	0.	0.
AGENCY 1	100.	0.	0.	0.	0.	0.	0.
AGENCY 2	0.	0.	0.	0.	0.	0.	100.
AGENCY 3	0.	0.	0.	0.	0.	0.	0.
AGENCY 4	0.	0.	0.	0.	0.	0.	0.
OT 5							
AGENCY 0	0.	0.	0.	0.	0.	0.	0.
AGENCY 1	33.	0.	0.	0.	0.	0.	33.
AGENCY 2	0.	0.	0.	0.	0.	0.	0.
AGENCY 3	0.	0.	0.	0.	0.	0.	0.
AGENCY 4	67.	0.	0.	0.	0.	0.	67.
OT 6							
AGENCY 0	0.	0.	0.	0.	0.	0.	0.
AGENCY 1	17.	0.	0.	0.	0.	0.	17.
AGENCY 2	0.	0.	0.	0.	0.	0.	0.
AGENCY 3	75.	0.	0.	0.	0.	0.	75.

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PAGE 3

	1970	1971	1972	1973	1974	TOTAL
AGENCY 4	8.	0.	0.	0.	0.	8.
OT 7						
AGENCY 0	0.	0.	0.	0.	0.	0.
AGENCY 1	21.	0.	0.	0.	0.	21.
AGENCY 2	79.	0.	0.	0.	0.	79.
AGENCY 3	0.	0.	0.	0.	0.	0.
AGENCY 4	0.	0.	0.	0.	0.	0.
OT 8						
AGENCY 0	67.	0.	0.	0.	0.	67.
AGENCY 1	7.	0.	0.	0.	0.	7.
AGENCY 2	26.	0.	0.	0.	0.	26.
AGENCY 3	0.	0.	0.	0.	0.	0.
AGENCY 4	0.	0.	0.	0.	0.	0.
OT 9						
AGENCY 0	83.	0.	0.	0.	0.	83.
AGENCY 1	4.	0.	0.	0.	0.	4.
AGENCY 2	13.	0.	0.	0.	0.	13.
AGENCY 3	0.	0.	0.	0.	0.	0.

AGENCY 4	0.	0.	0.	0.	0.
OT10					
AGENCY 0	3.	0.	0.	0.	3.
AGENCY 1	0.	0.	0.	0.	0.
AGENCY 2	97.	0.	0.	0.	97.
AGENCY 3	0.	0.	0.	0.	0.
AGENCY 4	0.	0.	0.	0.	0.
OT11					
AGENCY 0	0.	0.	0.	0.	0.
AGENCY 1	0.	0.	0.	0.	0.
AGENCY 2	5.	0.	0.	0.	5.
AGENCY 3	44.	0.	0.	0.	44.
AGENCY 4	0.	0.	0.	0.	0.
OT12					
AGENCY 0	0.	0.	0.	0.	0.
AGENCY 1	0.	0.	0.	0.	0.
AGENCY 2	14.	0.	0.	0.	14.
AGENCY 3	35.	0.	0.	0.	35.
AGENCY 4	0.	0.	0.	0.	0.
OT13					

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	1970	1971	1972	1973	1974	TOTAL
AGENCY 0	0.	0.	0.	0.	0.	0.
AGENCY 1	0.	0.	0.	0.	0.	0.
AGENCY 2	0.	0.	0.	0.	0.	0.
AGENCY 3	50.	0.	0.	0.	0.	50.
AGENCY 4	0.	0.	0.	0.	0.	0.
OT14						
AGENCY 0	0.	0.	0.	0.	0.	0.
AGENCY 1	0.	0.	0.	0.	0.	0.
AGENCY 2	0.	0.	0.	0.	0.	0.
AGENCY 3	6.	0.	0.	0.	0.	6.
AGENCY 4	44.	0.	0.	0.	0.	44.
OT15						
AGENCY 0	0.	0.	0.	0.	0.	0.
AGENCY 1	0.	0.	0.	0.	0.	0.
AGENCY 2	4.	0.	0.	0.	0.	4.
AGENCY 3	6.	0.	0.	0.	0.	6.

AGENCY 4	40.	0.	0.	0.	0.	0.	0.	0.	40.
OT16									
AGENCY 0	0.	0.	0.	0.	0.	0.	0.	0.	0.
AGENCY 1	0.	0.	0.	0.	0.	0.	0.	0.	0.
AGENCY 2	0.	0.	0.	0.	0.	0.	0.	0.	0.
AGENCY 3	0.	0.	0.	0.	0.	0.	0.	0.	0.
AGENCY 4	50.	0.	0.	0.	0.	0.	0.	0.	50.
OT17									
AGENCY 0	0.	0.	0.	0.	0.	0.	0.	0.	0.
AGENCY 1	0.	0.	0.	0.	0.	0.	0.	0.	0.
AGENCY 2	0.	0.	0.	0.	0.	0.	0.	0.	0.
AGENCY 3	44.	0.	0.	0.	0.	0.	0.	0.	44.
AGENCY 4	6.	0.	0.	0.	0.	0.	0.	0.	6.
OT18									
AGENCY 0	3.	0.	0.	0.	0.	0.	0.	0.	3.
AGENCY 1	0.	0.	0.	0.	0.	0.	0.	0.	0.
AGENCY 2	38.	0.	0.	0.	0.	0.	0.	0.	38.
AGENCY 3	3.	0.	0.	0.	0.	0.	0.	0.	3.
AGENCY 4	6.	0.	0.	0.	0.	0.	0.	0.	6.
OT19									
AGENCY 0	0.	0.	0.	0.	0.	0.	0.	0.	0.
AGENCY 1	50.	0.	0.	0.	0.	0.	0.	0.	50.

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	1970	1971	1972	1973	1974	TOTAL
AGENCY 2	0.	0.	0.	0.	0.	0.
AGENCY 3	0.	0.	0.	0.	0.	0.
AGENCY 4	0.	0.	0.	0.	0.	0.
OT20						
AGENCY 0	0.	0.	0.	0.	0.	0.
AGENCY 1	6.	0.	0.	0.	0.	6.
AGENCY 2	0.	0.	0.	0.	0.	0.
AGENCY 3	44.	0.	0.	0.	0.	44.
AGENCY 4	0.	0.	0.	0.	0.	0.

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CONSTRAINT

PARAMETRIC  
IMPROVEMENT

RANGE

OBJECTIVE: MINIMIZE COST

C50100	-53.00	-48.	TO	4.
C50101	-43.45	-41.	TO	0.
C50102	-54.83	-42.	TO	0.
C50103	-40.35	-58.	TO	0.
C50104	.00	-60.	TO	0.
C50200	-53.00	-48.	TO	4.
C50201	-43.45	-41.	TO	0.
C50202	-54.83	-42.	TO	0.
C50203	-40.35	-58.	TO	0.
C50204	.00	-60.	TO	0.
C50300	-53.00	-48.	TO	0.
C50301	-43.45	-41.	TO	0.
C50302	-54.83	-42.	TO	4.
C50303	-40.35	-58.	TO	0.
C50304	.00	-60.	TO	0.
C50400	-53.00	-48.	TO	0.
C50401	-43.45	-41.	TO	1.
C50402	-54.83	-42.	TO	0.
C50403	-40.35	-58.	TO	0.
C50404	.00	-60.	TO	0.
C50500	-53.00	-48.	TO	0.
C50501	-43.45	-41.	TO	0.
C50502	-54.83	-42.	TO	0.
C50503	-40.35	-58.	TO	0.
C50504	.00	-60.	TO	140.
C50600	-53.00	-48.	TO	1.
C50601	-43.45	-41.	TO	0.
C50602	-54.83	-42.	TO	0.
C50603	-40.35	-58.	TO	5.
C50604	.00	-60.	TO	0.
C50700	-53.00	-48.	TO	0.
C50701	-43.45	-41.	TO	1.
C50702	-54.83	-42.	TO	1.
C50703	-40.35	-58.	TO	0.
C50704	.00	-60.	TO	0.
C50800	-53.00	-48.	TO	1.
C50801	-43.45	-41.	TO	0.
C50802	-54.83	-42.	TO	0.
C50803	-40.35	-58.	TO	0.

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CONSTRAINT

RANGE

MARGINAL  
IMPROVEMENT

PAGE 2

C50804	.00	-60.	TO	0.
C50900	-53.00	-48.	TO	1.
C50901	-43.45	-41.	TO	0.
C50902	-54.83	-42.	TO	0.
C50903	-40.35	-58.	TO	0.
C50904	.00	-60.	TO	0.
C51000	-53.00	-48.	TO	4.
C51001	-43.45	-41.	TO	0.
C51002	-54.83	-42.	TO	4.
C51003	-40.35	-58.	TO	0.
C51004	.00	-60.	TO	0.
C51100	-53.00	-13.	TO	0.
C51101	-43.45	-11.	TO	0.
C51102	-54.83	-12.	TO	0.
C51103	-40.35	-16.	TO	5.
C51104	.00	-16.	TO	0.
C51200	-53.00	-13.	TO	0.
C51201	-43.45	-11.	TO	0.
C51202	-54.83	-12.	TO	4.
C51203	-40.35	-16.	TO	5.
C51204	.00	-16.	TO	0.
C51300	-53.00	-13.	TO	0.
C51301	-43.45	-11.	TO	0.
C51302	-54.83	-12.	TO	0.
C51303	-40.35	-16.	TO	5.
C51304	.00	-16.	TO	0.
C51400	-53.00	-49.	TO	0.
C51401	-43.45	-59.	TO	0.
C51402	-54.83	0.	TO	1.
C51403	-40.35	-83.	TO	0.
C51404	.00	-86.	TO	140.
C51500	-53.00	-48.	TO	0.
C51501	-43.45	-41.	TO	0.
C51502	-54.83	-42.	TO	5.
C51503	-40.35	-58.	TO	0.
C51504	.00	-60.	TO	140.
C51600	-53.00	-74.	TO	0.

C51401  
C51402  
C51403

-43.45  
-54.83  
-40.35

-63.  
-64.  
-89.

TO  
TO  
TO

0.  
0.  
0.

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CONSTRAINT

MARGINAL  
IMPROVEMENT

RANGE

PAGE 3

C51604  
C51700  
C51701  
C51702  
C51703  
C51704  
C51800  
C51801  
C51802  
C51803

.00  
-5.00  
-43.45  
-54.83  
-40.35  
.00  
-53.00  
-43.45  
-54.83  
-40.35

-92.  
-13.  
-11.  
-12.  
-16.  
-16.  
-48.  
-41.  
-42.  
-58.

TO  
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140.  
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5.  
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1.  
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C51804  
C51900  
C51901  
C51902  
C51903  
C51904  
C52000  
C52001  
C52002  
C52003

.00  
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-40.35

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-58.  
-60.  
-13.  
-11.  
-12.  
-16.

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1.  
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5.

C52004  
D301  
D302  
D303  
D304  
D305  
D306  
D307  
D308  
F501

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43.45  
43.45  
54.83  
54.83  
40.35  
40.35  
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196.  
199.  
79.  
179.  
179.  
176.  
245.  
245.  
58.

TO  
TO  
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TO  
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TO

0.  
248.  
248.  
121.  
221.  
222.  
222.  
266.  
266.  
103.

E502  
E503

-98.39  
-88.61

15.  
17.

TO  
TO

53.  
53.

E504  
E505  
E506  
E507  
E508  
E509  
E510  
E511

-86.32  
-115.32  
-93.32  
-77.32  
-83.32  
-83.32  
-94.32  
-111.39

74.  
74.  
90.  
94.  
63.  
63.  
58.  
40.

TO  
TO  
TO  
TO  
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101.  
181.  
103.  
101.  
101.  
101.  
104.  
53.

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RANGE

E512  
E513  
E514  
E515  
E516  
E517  
E518  
E519  
E520

-87.61  
-87.79  
-118.23  
-123.32  
-93.79  
-92.23  
-102.32  
-104.06  
-83.32

41.  
41.  
6.  
13.  
42.  
42.  
13.  
21.  
40.

TO  
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TO

53.  
53.  
126.  
136.  
117.  
53.  
51.  
51.  
53.

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